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CONTENTS

PAGE

EFFECTS OF CERTAIN ENVIRONMENTAL CONDITIONS ON THE PRODUCTION OF GREENHOUSE TOMATOES.....*By M. C. Strong* 3

BARN-DRIED HAY VERSUS HAY CROP SILAGE FOR WINTER FEEDING OF DAIRY COWS.....*By C. J. Little and A. R. Wolcott* 10

COEFFICIENTS OF DIGESTIBILITY OF IMMATURE ALFALFA, LADINO CLOVER, TIMOTHY AND QUACKGRASS HAYS.....
.....*C. F. Huffman, S. T. Dexter and C. W. Duncan* 16

PEA SEED TREATMENT INVESTIGATIONS (REPORT OF PROGRESS)
.....*Axel L. Andersen and Donald J. deZeeuw* 25

SOME EFFECTS OF BRUSHING AND SULFUR DUSTING OF PEACHES ON DECAY AND SHRIVELING.....*H. A. Cardinell* 34

POST HARVEST TESTS WITH PEACHES TO REDUCE SPOILAGE.....
.....*H. A. Cardinell and C. Guinn Barr* 39

(Continued on Next Page)

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CONTENTS

(Continued from Outside Front Cover)

PAGE

Wool Characteristics, Growth and Skin Folds in a Cross Between Rambouillet and Black Top Delaine Sheep *H. R. Hunt, Y. S. Ghanem, C. A. Lawson and G. A. Brown* 52

Effects of Stilbestrol-progesterone Implants on the Growth and Carcass Quality of Lambs.....*J. H. Galloway, L. J. Bratzler, L. H. Blakeslee and J. Meites* 68

Mechanical Stonepickers .....*H. F. McColly and F. W. Roth* 75

Recirculating Drier for Drying Pea Beans with Heated Air .....*Carl W. Hall and Robert L. Maddex* 83

Use of Corn Cobs as a Filler for Concrete Used in Farm Construction .....*J. S. Boyd and T. J. Brevik* 87

An Antifungal Principal in the Cell of *Achromobacter iophagum*.....*Gueh-djen Hsiung and E. H. Lucas* 95

Chemical Treatment of Potato Slices in Relation to the Extraction of Sugars and Other Dry Matter and the Quality of Potato Chips.....
.....*S. T. Dexter and D. K. Salunkhe* 102

Blood and Meat Spots in Chicken Eggs.....
.....*L. E. Dawson and H. R. Richardson* 110

Percentage Mortality of Pullets in their First Laying Year Compared with Survivors the Second Year.....
.....*E. W. Henderson* 120

A Silver Laced Chicken with Cornish Ancestry.....
.....*E. W. Henderson* 125

Are Farm Account Cooperators Better Than Average Farmers?.....*Russell Mawby and E. B. Hill* 130

Journal Article Abstracts..... 134

THE QUARTERLY BULLETIN

VOLUME 35 • NUMBER 1 • AUGUST 1952

MICHIGAN STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
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C. M. HARDIN, DIRECTOR
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EFFECTS OF CERTAIN ENVIRONMENTAL CONDITIONS ON THE PRODUCTION OF GREENHOUSE TOMATOES[1]

By M. C. STRONG
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MANY INVESTIGATORS have established the fact that greenhouse tomato production may be greatly improved by the use of growth regulators to induce fruit-setting (3, 4, 5, 7, 8), and this practice has been adopted by many growers. However, there is considerable variability with respect to the effectiveness of such chemical treatments, both in the published reports and in the experience of growers. The study reported here was undertaken in 1948 to determine whether the temperature and humidity in the greenhouse at the time of pollination or application of such growth regulators bore any relationship to the percentage of flowers which produced fruit and to the weight of the fruit harvested. Since sufficient evidence could not be obtained in a single season, the study was continued for 4 years on successive spring tomato crops.

METHODS

The tomatoes were grown in a sandy loam soil previously steam sterilized. Eighty plants were set 12 inches apart each way, with a 2-foot aisle between every two rows. Plants were pruned to a single stem and supported on 1-inch vertical wooden stakes which were fastened above to a series of wires so that tapping or shaking the wires would result in jarring the plants. Pollination of the flowers was accomplished in this manner. A 3-12-12 commercial fertilizer was applied when necessary, and applications of ammonium sulfate were used at regular intervals after harvest commenced. Moisture was supplied by ground irrigation when required.

[1]Contribution No. 52-11 from the Department of Botany and Plant Pathology, Michigan State College.

ARTICLE 35-1

Continuous temperature and humidity records were kept by means of a Fries recording hygrothermograph. Variations in temperature and humidity at time of pollination and hormone application were mostly secured by taking advantage of natural weather variations. Higher-than-normal humidities were obtained by closing the ventilators and spraying water on the steam pipes at regular intervals. Higher-than-normal temperatures were produced by opening all the steam heating lines or by opening the ventilators only slightly during periods of bright sunlight. The experimental conditions were maintained for at least 2 or 3 hours. Otherwise, night temperature was controlled at 65° F., and day temperatures ranged from 75° to 85° F., except in May and June when they occasionally ran higher.

The varieties of tomato grown were Marglobe, John Baer and a hybrid Globe × Waltham Forcing.

The growth regulators used to induce fruit-setting and improve production were beta-naphthoxyacetic acid (50 p.p.m.), the potassium salt of this acid (50 p.p.m.) and para-chlorophenoxyacetic acid (10 p.p.m.). The two acid solutions were made by dissolving the required weight of crystals in 50 ml. of 95 percent alcohol and diluting to 1 liter with water, while the potassium salt was dissolved in water directly. Growth regulators were applied to flower clusters with a DeVilbis atomizer No. 15.

Inflorescences with three or more well-opened flowers were selected for the tests. These clusters were tagged and a careful record kept of time and method of treatment, number of flowers setting fruit, time required for maturation and weight of individual fruit. Only fruit equivalent to commercial No. 1 grade were counted in the production records.

Forty plants were used for pollination and 40 for synthetic hormone treatments each season. One hundred to 250 flowers were included in every lot pollinated or sprayed with growth regulators. Treated clusters received a single spray application sufficient to thoroughly wet all open flowers and large buds. The dry corollas of old flowers were removed before spraying since these do not absorb the growth regulator. As new clusters bloomed every 4 or 5 days, treatments were repeated at different temperature and humidity levels. The accumulated records comprise five to ten experiments at each temperature and humidity level, using 200 to 500 flowers for each test.

RESULTS

Analysis of the production records indicates that humidity at time of pollination or synthetic hormone treatment had no interrelation with the percentage of flowers setting fruit or size of fruit produced (Figs. 1 and 2). However, there is a definite relationship between temperature and fruit set, either by pollination or induced by chemical treatment (Fig. 1). In either instance, a temperature of 80° F. appears to be optimal for fruit set. This is in agreement with the work of

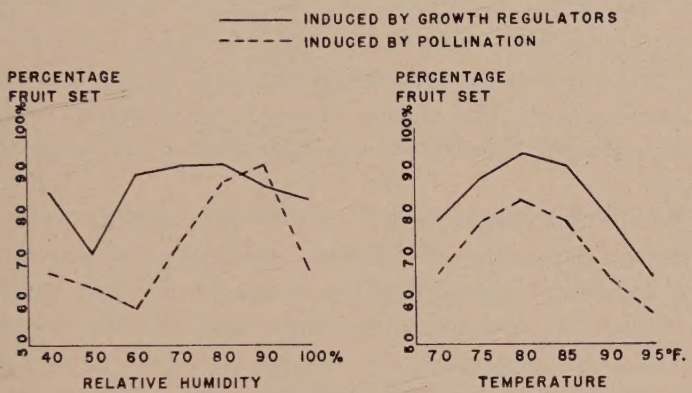
INDUCED BY GROWTH REGULATORS
INDUCED BY POLLINATION
PERCENTAGE FRUIT SET
50 60 70 80 90 100%
40 50 60 70 80 90 100%
RELATIVE HUMIDITY
PERCENTAGE FRUIT SET
50 60 70 80 90 100%
70 75 80 85 90 95°F.
TEMPERATURE

Fig. 1. The effect of relative humidity and temperature at time of pollination and treatment with growth regulators on the percentage of flowers setting fruit. Average of all tests on four greenhouse crops.

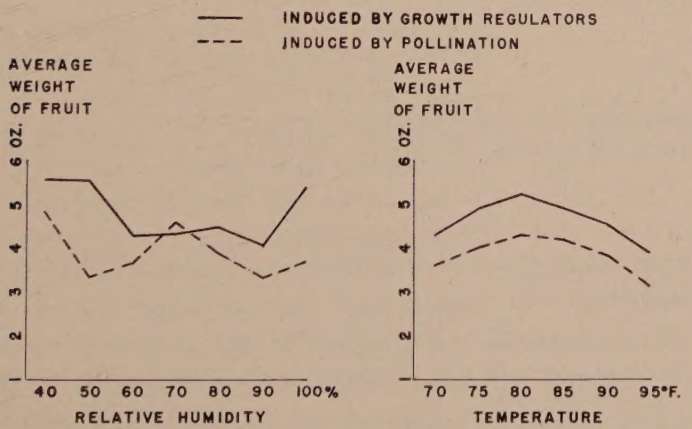
INDUCED BY GROWTH REGULATORS
INDUCED BY POLLINATION
AVERAGE WEIGHT OF FRUIT
2 3 4 5 6 OZ.
40 50 60 70 80 90 100%
RELATIVE HUMIDITY
AVERAGE WEIGHT OF FRUIT
2 3 4 5 6 OZ.
70 75 80 85 90 95°F.
TEMPERATURE

Fig. 2. The effect of relative humidity and temperature at time of pollination and treatment with growth regulators on average weight of individual fruit. Average of all tests on four greenhouse crops.

Went (9), who found in growing tomatoes under controlled environmental conditions that changes in humidity were not so important to plant growth as changes in temperature and that a day temperature of 26.5° C. (79.7° F.) was optimal for growth and fruit development. Smith and Cochran (6) reported that pollen germination and tube growth in tomato were low at 50° F. and 100° F. whereas germination and tube growth were much greater at 70° to 85° F.

The temperature at time of pollination or synthetic hormone treatment also has some influence on the growth initiated, as is shown by the curve in Fig. 2. The largest fruits produced either by pollination or hormone treatment resulted when fruit set was initiated at 80° F. although this temperature was not maintained throughout the course of fruit development. The figures shown in these graphs are averages of all tests including the three tomato varieties and three growth regulators used.

It will be noted (Figs. 1 and 2) that treatment with growth regulators increased the percentage of flowers setting fruit as well as fruit size over that resulting from pollination at all temperature levels tested.

The yields from beta-naphthoxyacetic acid and the potassium salt of this acid were compared to determine the effect of solvents. The potassium salt is water-soluble, while the acid requires alcohol as a solvent, which might affect ability to penetrate tissue or affect speed of evaporation. The results are shown in Fig. 3. The acid in alcoholic solution induced a higher percentage of fruit set at temperatures from 70° to 80° F., but at temperatures from 85° to 95° F. the potassium salt in water solution resulted in a greater fruit set. Whether these effects depend upon penetration by the growth regulator or speed of evaporation was not investigated.

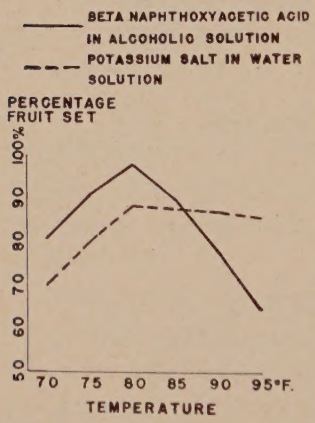

Fig. 3. Comparison between temperature at time of treatment and fruit set induced by beta-naphthoxyacetic acid in alcoholic solution and the potassium salt of this acid in water solution.

The time required for maturation of the fruit was not correlated with temperature or humidity at time of pollination and treatment with growth regulators; it did show, however, an inverse relationship to solar radiation during the period of maturation as shown in Fig. 4. Application of growth regulators decreased the time required for

maturation of treated fruits below that of pollinated fruits. This speeding-up of fruit development is one of the commercially important phases of synthetic hormone treatment, as previously pointed out by the author (7, 8) for tomatoes and by Blondeau and Crane (1) for figs. As solar radiation increases, the difference in maturation period between pollinated and treated fruits becomes less (Fig. 4).

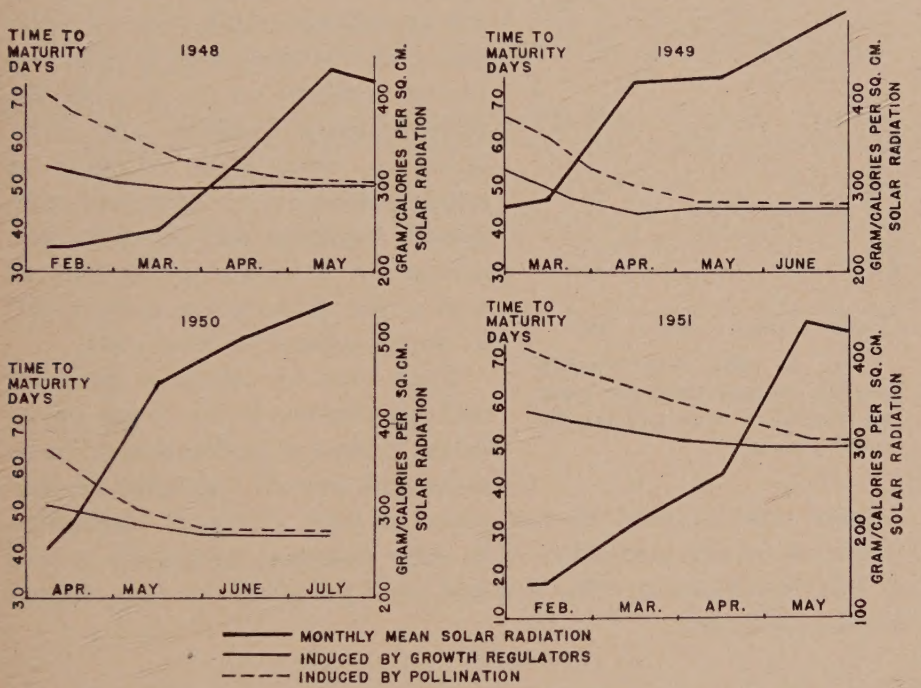

Fig. 4. Yearly comparison between time required for maturation of fruit resulting from pollination or growth regulator treatments and monthly solar radiation.

While growth regulators can greatly improve tomato fruit production from the standpoint of yield, fruit size and maturation time, light and plant nutrients are the limiting factors. Hemphill and Murneek (2) have recently investigated the effect of solar radiation on tomato yields. The relationship between average yields per plant and solar radiation during the period of fruit production in each of the four seasons of the present study (Fig. 5) is in accord with their conclusions that synthetic hormone sprays increase the efficiency of the plant

in the use of solar radiation[2] and the increase is most evident when the amount of available light is least.

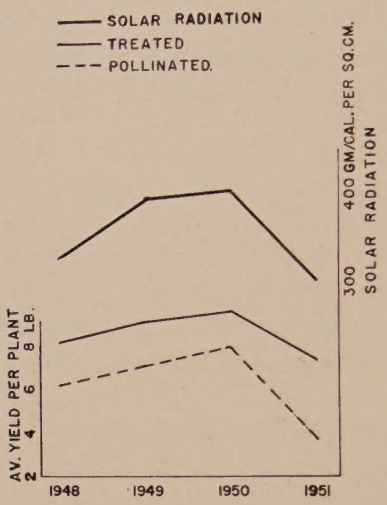

Fig. 5. The relationship between average yield per plant and mean daily solar radiation by growth seasons.

SUMMARY AND CONCLUSIONS

Tests on four successive spring tomato crops of the effect of relative humidity and temperature levels in the greenhouse at the time of pollination or treatment with growth regulators indicate no relationship between relative humidity and yield. However, temperature at time of either pollination or treatment with growth regulators does affect the percentage of blossoms setting fruit as well as the ultimate size of fruit, 80° F. being optimal for best yield.

There was no effect of humidity and temperature levels in the greenhouse at time of pollination or treatment with growth regulators on subsequent time required for maturation of fruit. Time of maturation shows an inverse correlation with solar radiation during the period of fruit development. The seasonal yield per plant was also related to solar radiation.

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[2]Solar radiation means (expressed in gram/calories per sq. cm.) in Fig. 4 and 5 are from the Monthly Weather Review for 1948, 1949, 1951 and National Summary, Climatological Data for 1950 published by the Weather Bureau, U. S. Department of Commerce.

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BARN-DRIED HAY VERSUS HAY CROP SILAGE FOR WINTER FEEDING OF DAIRY COWS

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EXCESSIVE RAINFALL is the rule rather than the exception during the hay harvesting season in the upper peninsula of Michigan. Consequently, field curing of hay generally results in excessive weather damage. Lutz and Wolcott (1)showed that under upper peninsula conditions hay crop silage harvested the last of June was superior for milk production to hay harvested the first of August and somewhat superior to barn-dried hay cut the middle of July. The purpose of this experiment was to compare, on the basis of milk production, barn-cured hay and hay crop silage cut at about the same time.

EXPERIMENTAL PROCEDURE

The crops used in this study were grown on two long, narrow strips of 15 acres each which were selected out of an 80-acre field in such a manner as to include the major variations in stand and botanical composition of the hay. The botanical composition was as follows: Alfalfa 16.5 percent; alsike 4.5 percent; red clover 11.8 percent; quackgrass 31.4 percent; timothy 18.8 percent; bromegrass 12.5 percent, with the remaining 4.5 percent being composed of weeds. The two strips were cut separately.

The hay crop for silage was cut June 27, 28, and 29 and comprised the outside one-third of the hay from strips. The hay crop for silage was cut with a mower with a windrower attachment and picked up immediately with a forage chopper which was set to chop at a theoretical one-fourth inch cut. The loads of chopped green forage were weighed, and 50 pounds of molasses per ton of green weight was added as the hay was blown into the silo. Owing to interruptions from light

[1]Acknowledgment is made to the Department of Agricultural Chemistry for the chemical analyses of the roughages.

ARTICLE 35-2

rains which fell daily, three days were required to fill the silo. The top of the silage was tramped down every day for 10 days after filling. However, the silage settled an additional 2½ to 3 feet during the summer and fall. During this period the silage pulled away from the sides at the top, resulting in considerable spoilage in that region.

The hay for barn drying was cut July 5, 6, and 7. An average of three samples cut at random from the standing hay on July 5 was composited. The composite sample contained 74.7 percent moisture. The hay was allowed to wilt in the swath before windrowing. It was allowed to cure in the windrow until a slight brittleness could be detected in the outside leaves. At that time the insides of the windrows were still tough but thoroughly wilted. The hay was then chopped to a theoretical 4-inch cut and blown into the mow at an average moisture content of 31.7 percent (average of three composite samples).

The hay was dried to safe storage moisture content by forced air without the addition of heat. High humidity made it necessary to use the blower intermittently to prevent heating. On days when the humidity was not high, the blower was operated continuously during the daytime. It was turned on again for an hour at 9:00 p. m. to eliminate heat, but was not operated through the night.

The feeding value of hay crop silage and barn-dried hay were compared in a feeding experiment using three groups of Holstein cows. The cows were depleted of their reserve by feeding them on an all-hay ration for periods ranging from 30 to 60 days prior to beginning the experiment. A decline and leveling off in milk production indicated depletion. No grain was fed. The daily roughage allowance was weighed and fed in equal portions night and morning. Roughage not consumed was weighed back and recorded. Mangers were constructed with individual divisions to prevent loss of feed. Water was available from individual drinking cups at all times. Two ounces of iodized salt and four ounces of steamed bonemeal plus cobalt were fed each cow daily. The cows were kept in stanchions for the duration of the feeding experiment.

Five cows were in group I, and four cows each in groups II and III. The groups were similar in average age, days in milk, body weight, and milk production at the beginning of the experiment. The cows were milked twice daily. The milk was weighed and samples taken for butterfat determinations at each milking. Milk samples were preserved with corrosive sublimate, and butterfat tests were made every third day on three-day composite samples. Each cow was weighed daily

for three days prior to the beginning of the experiment. The mean weight was used as the base weight of the cows. The cows were weighed the second day of each three-day period at about the same time of day.

The cows in group I (control) received only barn-dried hay throughout the trial. Groups II and III were used in a double reversal experiment, with 21 days in each period. The four cows in group II were fed hay, silage and hay in the first, second and third periods, respectively. The four cows in group III were fed silage, hay and silage for the three periods in the order listed. The data for the last 15 days in each period were used in the calculation of results.

Age, stage of lactation, milk production and body weight of the cows are presented in Table 1. The chemical composition of the forage is presented in Table 2. The amount of roughage consumed, average body weight, and the yield of 4-percent fat-corrected milk (F.C.M.) are listed in Table 3.

There was little difference in dry matter intake or change in body weight and milk production for the control group I throughout the experiment.

For the first period group II received barn-dried hay, and had an average daily dry matter consumption of 32 pounds and produced 24.5 pounds of 4-percent F.C.M. During the second period on hay crop silage and with an average daily intake of 30.3 pounds of dry matter, they produced an average of 25.2 pounds of 4-percent F.C.M., an average increase of 0.7 pound per day on hay crop silage although the dry matter intake averaged 1.7 pounds less each day. During the third period group II on barn-dried hay, which had a dry matter intake of 32.3 pounds a day produced 22.3 pounds of 4-percent F.C.M. daily. This represents an average difference of 2.9 pounds per day less than during the previous period. Body weight changes during the three periods were as follows: a 25-pound loss during the first period, a 43-pound loss during the second period, and a 53-pound gain during the third period.

The average daily milk production on hay crop silage for group III during the first period was 23.8 pounds per day of 4-percent F.C.M. on an average intake of 25.5 pounds of dry matter. During the second period the cows in group III received an average dry matter intake of 32.1 pounds of barn-dried hay and produced a daily average of 23.7 pounds of 4-percent F.C.M. The cows regained lost body weight during the third period on an intake of 29.2 pounds of dry matter from

TABLE 1—Age, stage of lactation, milk production, and body weight of the cows at the start of the experiment

Cow No.	Age Yrs.-Mos.	In milk days	Average daily milk production,* pounds	Average base weight, pounds
		Group I		
489	6–10	395	26.5	1,411
08	6–0	79	39.3	1,243
49	3–11	130	20.2	1,047
55	2–7	140	19.9	1,067
Average	4–10	186	26.48	1,192
		Group II		
57	2–6	73	24.0	1,064
04	6–3	108	31.9	1,319
495	6–6	316	26.4	1,281
24	5–9	212	19.9	1,240
Average	5–3	177.25	25.55	1,226
		Group III		
43	3–4	260	21.5	1,193
07	6–0	247	25.1	1,393
480	7–3	265	22.8	1,404
59	2–4	83	29.7	1,064
35	4–11	48	37.4	1,102
Average	4–8	180.6	27.3	1,232

*Average daily milk production December 18–27.

grass silage, and the average daily milk production dropped to 22.9 pounds daily of 4-percent F.C.M.

The cows lost body weight during all the hay crop silage periods. This probably was due to a reduction of "fill" in the digestive tract rather than a real loss in body weight since the feeding of the relatively high moisture silage had a laxative effect on the cows.

The hay crop silage and barn-dried hay used in this experiment were comparable except for a one-week difference in cutting dates. The hay for silage was cut June 27, 28, and 29 and that going into the hay drier was cut July 5, 6 and 7.

A previous study in the Upper Peninsula encountered conditions of weather that caused a greater difference in harvesting dates (1). Under those conditions, hay crop silage harvested the last of June was superior for milk production to barn dried hay harvested the middle of July.

TABLE 2—Chemical compositions of barn-dried hay and hay crop silage as fed

Date used		Moisture	Ash	Ether extract	Fiber	Protein	N.F.E.	Carotene, Micrograms per gram	pH
		Percent							
HAY CROP SILAGE									
Jan. 2-22	(W.B.)*	75.2	1.5	1.4	8.3	3.0	10.5	40.0	4.25
	(D.B.)†	0	6.2	5.6	3.6	12.2	42.3	161.4	
Jan. 23-Feb. 12	(W.B.)	73.2	1.8	1.0	8.7	3.4	11.9	40.4	4.17
	(D.B.)	0	6.5	3.8	52.5	12.8	44.3	160.6	
Feb. 13-Mar. 5	(W.B.)	72.7	1.7	1.0	8.9	3.2	42.1	43.0	4.04
	(D.B.)	0	6.1	3.8	32.8	11.8	45.5	157.6	
BARN-DRIED HAY									
Jan. 2-22	(W.B.)	11.0	4.7	1.9	28.7	10.3	43.3	30.6	
	(D.B.)	0	5.2	2.2	32.3	11.6	48.7	34.3	
Jan. 22-Feb. 12	(W.B.)	11.0	4.5	1.9	29.5	9.4	43.7	30.7	
	(D.B.)	0	5.1	2.1	33.1	10.6	49.1	34.5	
Feb. 12-Mar. 5	(W.B.)	10.4	4.5	1.9	30.3	9.7	43.2	33.3	
	(D.B.)	0	5.1	2.2	33.8	10.8	48.1	37.1	

*Wet basis.
†Dry basis.

TABLE 3—The average roughage intake (wet and dry), body weight and 4-percent F.C.M. by periods for the three groups of cows†*

Experimental period	Group	Ration	Average roughage consumed, lb.		Average body weight, lb.			4% F.C.M. per day, lb.
			Wet	Dry	Start	End	Diff.	
1.....	I....	B.D. hay‡..	35	31.1	1,206	1,194	−12	23.6
2.....	I....	B.D. hay...	35	31.2	1,216	1,212	− 4	23.7
3.....	I....	B.D. hay...	36	32.3	1,169	1,224	−55	21.3
1.....	II....	B.D. hay...	36	32.0	1,188	1,163	−25	24.5
2.....	II....	Silage.....	113	30.3	1,181	1,138	−43	25.2
3.....	II....	B.D. hay...	36	32.3	1,133	1,191	−53	22.3
1.....	III....	Silage.....	103	25.5	1,133	1,097	−33	23.8
2.....	III....	B.D. hay...	36	32.1	1,155	1,179	−24	32.7
3.....	III....	Silage.....	107	29.2	1,152	1,149	− 3	22.9

*Average body weight at the start and end of the last 15 days of the periods.
†Data for last 15 days were used in each period in the calculation of results.
‡Barn-dried hay.

SUMMARY

Hay crop silage was compared with barn dried hay in an all roughage ration. Three groups of cows were fed as follows: Group I (the control group) was fed barn-dried hay continuously. Groups II and III were used in a double reversal experiment with group II receiving hay, silage and hay, and group III receiving silage, hay and silage, respectively, during the three periods.

There were no significant differences between barn-dried hay and hay crop silage as to influence on milk production, butterfat test and body weight under conditions of this experiment.

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COEFFICIENTS OF DIGESTIBILITY OF IMMATURE ALFALFA, LADINO CLOVER, TIMOTHY AND QUACKGRASS HAYS

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DEPARTMENTS OF DAIRY, FARM CROPS AND AGRICULTURAL CHEMISTRY

NUMEROUS DATA have been published on the chemical composition of immature hays, but there is a paucity of data in the literature concerning the coefficients of digestibility for such crops. Woodman *et al.* (14, 15, 16) determined the chemical composition and digestibility of English-grown alfalfa hay, harvested at various stages of maturity, by the use of sheep. Newlander *et al.* (8) and Salmon *et al.* (11) compiled the data on the chemical composition and coefficients of digestibility of immature hay crops grown in the United States. The present paper records the chemical composition and coefficients of digestibility of immature hays used in various nutrition experiments at this station.

EXPERIMENTAL

The digestion trials were conducted with cows and two-year old heifers. The actual fecal collection periods were preceded by at least 14 days on the hay crop at the same level of feeding as was used during the collection period. The collection period was of 10 days duration. No supplementary feed was fed.

Hays 1 and 2 were early-bud alfalfa cut on the same day. Hay No. 2 was harvested with a crusher, cured in windrows and stored in the mow on the third day. Hay No. 1 also was cured in windrows and was stored in the mow on the fourth and fifth days without having been rained on. These two hays graded U. S. No. 1 on color and leaf. Hays 3, 4 and 5 were first cutting alfalfa harvested from the same field. Hay No. 3 was cut in full-bud on June 8 with a mower, cured in windrows and hauled to the mow 5 and 6 days later (it contained 20 to 25 percent moisture when stored). Hay No. 4 was cut in one-tenth bloom on June 11 with a mower, cured in windrows and hauled to the barn on June 13. Hay

ARTICLE 35-3

No. 5 was cut in full-bloom on June 24, cured in windrows and stored in the barn on June 27 and 29. Hays 6 and 7 were alfalfa harvested from the same field. Hay No. 6 was first cutting, harvested in the early-bud stage and cured on a fence. Hay No. 7 was second cutting, harvested in the early-bud stage and field cured. The mixed ladino clover and bromegrass hay was cut in full-bloom of the ladino and cured in field windrows (No. 8). Immature ladino clover was cut in the early-bloom stage and cured in a mow drier to a depth of 3 to 4 feet (No. 9). The ladino clover-ryegrass mixture (50 percent each) was cut when the ladino clover was in the bloom stage, wilted slightly and dehydrated in a high temperature dryer (No. 10). The timothy hay (No. 11) was cut at the "boot" stage and cured on a fence, while timothy hay No. 12 was cut in the "pre-boot" stage and cured in the swath under adverse weather conditions. No. 13 was quackgrass cut in the immature stage and field cured.

RESULTS AND DISCUSSION

The chemical composition, coefficients of digestibility and total digestible nutrients of the various hays are shown in Tables 1 and 2. In Table 1, the lines designated as (1) refer to the chemical analysis of the hay, and the lines designated as (2) refer to the coefficients of digestibility. From two to four cows were used to determine the digestibility of each hay. Alfalfa hays 1 and 2 showed close agreement in chemical analysis, on the dry basis, in coefficients of digestibility and total digestible nutrients. These two hays contained 31.6 and 27.8 percent crude fiber, respectively, on the dry basis. The crushed hay contained the lower crude fiber content, but there was no significant difference between these two hays in total carbohydrate content.

Alfalfa hays 3, 4 and 5 were from the same field, harvested the same season, but cut at different stages of maturity. The chemical composition on the dry basis of the full-bud, one-tenth-bloom and full-bloom were: protein 19.6, 15.3 and 15.3; crude fiber 35.7, 37.9 and 34.5; and total digestible nutrients 55.5, 56.3 and 57.3, respectively. There was no significant difference among these three hays in the coefficients for organic matter. The coefficients of digestibility of protein was highest for the full-bud hay (No. 3), while hays 4 (one-tenth-bloom) and 5 (full-bloom) had higher coefficients for nitrogen-free extract. The coefficients for crude fiber of hays No. 3 and 4 were somewhat higher than for hay 5 (full-bloom).

TABLE 1—Chemical composition and coefficients of digestibility of immature hays as fed to the cows

Hay No.	Description	D.M.	O.M.	Ash	Protein	Ether ext.	Crude fiber	N.F.E.	T.D.N.
1	Alfalfa.....(1)*	88.7	81.3	7.45	14.5	1.64	28.0	37.1	....
	1st cut.....(2)†	58.2	61.6	....	62.4	−2.5	57.2	67.6	50.1
	early-bud...(2)	61.4	64.6	....	68.4	24.2	58.9	69.2	53.0
	1936 crop...(2)	58.2	61.4	....	63.4	15.0	55.7	67.1	50.2
	Average (2)	59.3	62.5	....	64.7	12.3	57.3	68.0	51.1
2	Alfalfa.....(1)	87.2	80.0	7.25	14.7	1.89	24.2	39.2	....
	1st cut.....(2)	60.5	64.0	....	67.2	46.7	52.8	70.5	52.3
	early-bud...(2)	63.0	66.0	....	73.2	13.6	54.6	72.9	53.1
	crushed.....(2)	56.5	59.2	....	64.8	9.0	40.4	71.1	47.6
	1936 crop...(2)	59.6	61.6	....	68.3	−6.6	54.0	67.0	49.1
	Average (2)	59.9	62.7	....	68.4	15.7	50.5	70.4	50.5
3	Alfalfa.....(1)	86.8	80.0	6.78	17.0	1.90	31.0	30.1	....
	1st cut.....(2)	56.5	57.8	....	72.8	19.9	56.8	52.8	46.7
	full-bud.....(2)	59.3	60.0	....	70.3	25.7	52.5	64.0	48.6
	1936 crop...(2)	60.0	60.9	....	70.0	20.0	52.4	67.0	49.2
	Average (2)	58.6	59.6	....	71.0	21.9	53.9	61.3	48.2
4	Alfalfa.....(1)	86.2	80.0	6.16	13.2	1.38	32.7	32.8	....
	1st cut.....(2)	55.9	59.4	....	60.6	−1.9	55.7	65.8	47.7
	1/10-bloom .(2)	55.5	58.6	....	67.1	34.9	48.9	65.7	47.5
	1936 crop...(2)	60.7	63.5	....	63.7	−31.8	64.9	65.8	50.3
	Average (2)	57.4	60.5	....	63.8	0.4	56.5	65.8	48.5
5	Alfalfa.....(1)	86.1	80.0	6.09	13.2	2.51	29.7	34.6	....
	1st cut.....(2)	57.5	60.8	....	63.0	42.0	54.0	67.2	50.0
	full-bloom . .(2)	56.3	60.2	....	69.3	58.5	50.8	64.8	50.0
	1936 crop...(2)	57.0	58.8	....	65.2	23.3	46.3	69.6	47.8
	Average (2)	56.9	59.9	....	65.8	41.3	50.4	67.2	49.3
6	Alfalfa.....(1)	88.1	81.8	6.30	16.5	1.67	29.9	33.7	....
	1st cut.....(2)	57.7	60.7	....	70.3	5.1	51.8	66.6	49.7
	early-bud...(2)	53.1	56.9	....	67.1	10.0	49.6	60.7	46.7
	1941 crop...(2)	55.1	58.5	....	66.8	3.0	49.5	65.3	47.9
	.....(2)	55.5	58.7	....	65.7	−13.9	50.8	66.0	48.8
	Average (2)	55.4	58.7	....	67.5	1.1	50.4	64.7	48.3

*Chemical composition expressed as a percentage.
†Coefficients of digestibility.

TABLE 1—Continued

Hay No.	Description	D.M.	O.M.	Ash	Protein	Ether ext.	Crude fiber	N.F.E.	T.D.N.
7	Alfalfa.....(1)	88.9	84.8	4.06	14.1	1.29	31.7	37.8	....
	2nd cut.....(2)	61.9	63.8	....	69.5	−5.8	55.8	70.7	54.4
	early-bud...(2)	64.0	65.7	....	70.7	8.5	57.5	72.5	55.9
	1941 crop...(2)	62.8	64.8	....	69.4	5.1	56.4	71.9	55.0
	.....(2)	63.2	65.1	....	71.8	−2.4	57.0	71.4	55.3
	Average (2)	63.0	64.9	....	70.4	1.4	56.7	71.6	55.2
8	Mature ladino....(1)	88.0	80.9	7.14	13.4	2.62	25.0	39.8	....
	clover and (2)	64.8	66.6	....	67.2	41.3	65.6	68.9	55.3
	young brome(2)	64.8	66.5	....	65.6	38.5	67.3	68.2	55.0
	grass 1944 crop...(2)	64.5	66.2	....	67.9	41.3	56.9	67.6	54.9
	Average (2)	64.7	66.4	....	66.9	40.4	63.3	68.2	55.1
9	Ladino clover....(1)	87.3	79.5	7.78	18.1	1.66	15.6	44.2	....
	immature...(2)	71.5	74.4	....	71.2	30.5	68.3	79.4	59.8
	1946 crop...(2)	74.8	77.2	....	75.1	38.2	70.1	81.9	62.2
	Average (2)	73.2	75.8	....	73.2	34.4	69.2	80.7	61.0
10	Ladino clover and (1)	87.8	80.6	7.23	13.5	2.78	20.1	44.2	....
	ryegrass..(2)	73.4	76.1	....	66.9	44.1	76.1	81.0	62.9
	1949 crop...(2)	73.0	75.5	....	65.7	40.3	75.6	80.6	62.2
	Average (2)	73.2	75.8	....	66.3	42.2	75.9	80.8	62.6
11	Timothy....(1)	88.7	82.6	6.14	10.9	2.99	31.9	36.8	....
	"boot" stage (2)	65.1	66.8	....	61.7	27.7	79.8	60.3	56.3
	1941 crop...(2)	67.1	68.8	....	65.8	34.4	78.7	63.8	58.1
	.....(2)	64.8	66.7	....	59.0	29.3	78.7	61.6	56.2
	.....(2)	62.9	64.4	....	59.7	17.8	75.7	59.9	53.9
	Average (2)	65.0	66.7	....	61.6	27.3	78.2	61.4	56.1
12	Timothy....(1)	90.0	84.7	5.26	11.8	1.81	28.2	42.9	....
	"pre-boot" stage.....(2)	73.9	75.6	....	73.4	56.2	78.0	75.4	65.3
	1942 crop...(2)	72.7	76.7	....	72.1	48.5	75.4	72.2	62.7
	Average (2)	73.3	76.2	....	72.8	52.4	76.7	73.8	64.0
13	Quackgrass.(1)	85.0	79.4	5.62	12.8	2.92	25.6	38.1	....
	immature...(2)	68.6	69.1	....	69.2	37.4	76.8	66.2	56.2
	.....(2)	67.4	66.4	....	69.2	32.5	73.3	63.5	54.0
	.....(2)	66.9	68.3	....	70.1	34.7	75.2	65.5	55.5
	Average (2)	67.6	67.9	....	69.5	34.9	75.1	65.1	55.2

TABLE 2—Chemical composition, digestible protein and total digestible nutrient content of the hays

(All values expressed as percent on the dry basis)

Hay No.	Ash	Protein	Ether ext.	Crude fiber	N.F.E.	Dig. protein	T.D.N.
1	8.40	16.3	1.85	31.6	41.8	10.5	57.6
2	8.31	16.9	2.17	27.8	45.0	11.6	57.9
3	7.81	19.6	2.19	35.7	34.7	13.9	55.5
4	7.15	15.3	1.60	37.9	38.1	9.8	56.3
5	7.07	15.3	2.92	34.5	40.2	10.1	57.3
6	7.15	18.7	1.90	33.9	38.3	12.6	54.8
7	4.57	15.9	1.45	35.7	42.5	11.2	62.1
8	8.11	15.2	2.98	28.4	45.2	10.2	62.6
9	8.91	20.7	1.90	17.9	50.6	15.2	69.8
10	8.23	15.4	3.17	22.9	50.3	10.2	71.3
11	6.92	12.3	3.37	36.0	41.5	7.6	63.2
12	5.84	13.1	2.01	31.3	47.7	9.5	71.1
13	6.61	15.1	3.44	30.1	44.8	10.5	64.9

Alfalfa hay 6 (first cutting, early-bud) and 7 (second cutting, early-bud) contained 18.7 and 15.9 percent protein, 33.9, 35.7 percent crude fiber and 54.8 and 62.1 percent total digestible nutrients, on the dry basis. The coefficients of digestibility of hays 6 and 7 were: protein 67.5 and 70.4, crude fiber 50.4 and 56.7, nitrogen-free extract 64.7 and 71.6 percent, respectively, on the dry basis.

Contrary to common opinion, the early-bud alfalfa hays used in this study were not particularly high in protein and total digestible nutrients and low in crude fiber. These results are in agreement with the data summarized by Schneider (10) for pre-bloom, early-bloom and full-bloom alfalfa hays. The early-bud alfalfa hays used in this work were lower in protein than the bud alfalfa used by Woodman *et al.* (14, 15, 16) which contained from 19.1 to 24.3 percent protein on the dry basis. Woodman *et al.* (16) reported that the coefficients of digestibility of organic matter of bud alfalfa varied from 62.4 to 67.3 when sheep were used as the test animals. These values are higher than those reported in this paper (58.7 to 64.9).

Salmon *et al.* (11) reported that bud alfalfa hay varied from 15.4 to 25.0 percent in protein and from 19.2 to 28.2 percent in crude fiber on the dry basis. They also reported the following coefficients of digestibility for crude fiber in bud alfalfa over a 3-year period as 32, 27 and 47, respectively.

The results reported in this paper are in agreement with those of Widtsoe (13) who found that there was not always a significant difference in the protein content of alfalfa hays cut in the bud and medium flower stage. He also found that first cutting, early-bud, early-bloom and medium-bloom alfalfa hays contained 28.1, 30.5 and 33.7 percent crude fiber, whereas second cutting contained 21.1, 32.2 and 33.5 percent crude fiber, respectively, on the dry basis. Foster and Merrill (6) reported that early-cut alfalfa hay was usually higher in protein than medium- and late-cut alfalfa hay, yet in 1897, first early (early-bloom), medium (full-bloom) and late (one-half of blooms had fallen) alfalfa contained 10.4, 11.0 and 12.2 percent protein on the dry basis, respectively. These investigators also reported that alfalfa cut when the first blooms appeared varied from 27.5 to 33.0 percent crude fiber on the dry basis, but in one year the crude fiber in early-cut was higher than that in the medium-cut alfalfa. Clarke (3) determined the variations in the protein content of alfalfa as the plant matured, and found that the protein content of alfalfa cut in the bud stage varied from 14.8 to 24.0 percent on the dry basis. Similar variations in the protein content of alfalfa were found by Sotola (12), although the mean protein content tended to decrease with maturity; *i.e.*, first cutting, one-fourth-bloom contained 11.8 and three-fourths-bloom alfalfa contained 11.4 percent protein on the dry basis. Dawson *et al.* (5) found that there was no significant difference in the protein and crude fiber content of alfalfa hay cut in the initial-bloom and half-bloom stages, but the coefficients of digestibility as determined with sheep for initial-bloom, half-bloom and full-bloom alfalfa were: protein 77.7, 77.1 and 75.4; crude fiber 47.7, 41.4 and 38.3; and nitrogen-free extract 72.3, 71.3 and 66.2, respectively.

The coefficients of digestibility of the constituents in ladino clover hay No. 9, which was cut in the immature stage, were greater, with the exception of ether extract, than for the more mature ladino clover hay No. 8. The percentage of crude protein also was higher and that of the crude fiber was lower in the immature hay. Loosli *et al.* (7) reported the average coefficients for ladino clover hay used in two experiments as follows: dry matter 71.6, protein 76.5, ether extract 26.5, crude fiber 60.2, nitrogen-free extract 76.9 and total digestible nutrients 60.3. The coefficient for dry matter as reported by Loosli *et al.* was lower than for the immature ladino hay No. 9, but higher than the mature ladino No. 8. Ladino No. 9 (immature) showed a slightly lower coefficient for protein but somewhat higher coefficients for crude fiber and nitrogen-

free extract. The total digestible nutrients of ladino clover hay No. 8 showed good agreement with the value reported by Loosli *et al.* The mean protein content of the two ladino clover hays used by Loosli *et al.* was 21.7 percent protein on the dry basis, compared with 20.7 for ladino hay No. 9 and 15.2 percent for ladino hay No. 8 (mature).

Hay No. 10 which was a mixture of ladino clover and English ryegrass compared favorably with immature ladino hay No. 9 from the standpoint of coefficients, but the percentage of protein on the dry basis was lower and the crude fiber content was higher.

The coefficients of digestibility of timothy cut in the "boot" stage (No. 11) and "pre-boot" stage (No. 12) were significantly higher in case of the "pre-boot" stage, with the exception of the coefficients for crude fiber which were about the same. The difference in coefficients was reflected in the total digestible nutrient values, 63.2 and 71.1 percent, respectively, for "boot" stage and "pre-boot" stage timothy hays (dry basis). Prince *et al.* (9) cited the work of Ritzman *et al.*, who determined the digestibility of protein and energy of timothy hay cut at three stages of maturity, to show that the earliest cut hay was far superior to hay cut later. Colovos *et al.* (4) cut timothy from the same field at three different stages of maturity and cured it in the field. Timothy cut on June 21, when 16 to 18 inches high and about 10 percent of the heads showing was the early cut; that harvested July 5, in early-bloom was medium-cut; while that cut July 25, in the seed-stage was the late-cut timothy. The coefficients of digestibility of the protein for the three cuttings were 55.4, 45.5 and 30.2 percent and the energy coefficients were 64.5, 55.4 and 49.6 percent, respectively.

Newlander *et al.* (8) determined the coefficients of digestibility of the feed constituents of timothy hays cut a) with no-blooms showing, b) in full-bloom and c) slightly past full-bloom. A part of these hays was cured in the field and a part was artificially dried. The chemical analyses and the coefficients for pre-bloom timothy hay are in agreemet with those reported in this paper for the "boot" stage timothy. Bartlett (2) compared early- and late-cut timothy. Although the crude fiber content of the early-cut hay was only 29.2 percent on the dry basis, the coefficient of digestibility was 58.7 as compared to 78.2 for the "boot" stage timothy reported in this paper. The coefficients of digestibility of the crude protein and crude fiber of the immature quackgrass were 69.5 and 75.1, respectively, compared with 57 and 61 for full-bloom quackgrass as reported by Bartlett (1, 2) who used sheep in the determination of coefficients of digestibility. The immature quack-

grass contained 15.1 percent protein on the dry basis compared with 8.7 percent for full-bloom quackgrass as reported by Bartlett.

It is evident from the data presented in this paper that alfalfa cut in the bud stage is not always high in protein and total digestible nutrients and low in crude fiber. These results are in agreement with the findings of most investigators.

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PEA SEED TREATMENT INVESTIGATIONS[1]
(REPORT OF PROGRESS)

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SEED TREATMENT of peas with commercial fungicides to prevent seed decay and damping-off is becoming standard practice in agricultural production. Since new chemicals are being developed for seed treatment purposes every year, it is necessary to compare the newer formulations with the older products in keeping growers informed as to the better seed protectants and their methods of application. Disease control through the application of seed treatment compounds may play an important role in meeting the nation's food production schedules.

The results presented here were obtained during the last three years. The investigations include a comparison of the effectiveness of several chemical formulations as seed treatment materials for the control of damping-off of peas. Methods of application and other factors which may play an important role in the use of chemicals as seed protectants were also considered.

MATERIALS AND METHODS

The seed used in the studies was furnished by the Ferry-Morse Seed Company, Detroit, Michigan. The chemicals used to treat the seed, their basic compositions and the manufacturers are given in Table 1.

The chemicals were applied to the seed on the basis of ounces per 100 pounds of seed, generally at the dosages recommended by the manufacturer or at higher rates when deemed necessary. When the chemical was applied as a slurry, a few drops of a 7-percent Methocel (Dow Chemical Company trade name for methyl cellulose) solution

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ARTICLE 35-4

TABLE 1—Name, chemical composition, and source of the materials used in the pea seed treatment studies

Trade or code name	Active principle	Source
Agrox	Phenyl mercury urea (6.7%)	Chipman Chem. Co.
Amine S	High mol. wt. tertiary amine	Alrose Chem. Co.
Arasan (Thiram)	Tetramethylthiuram disulphide (50%)	E. I. du Pont de Nemours & Co. (Inc.)
Arasan SF (Thiram)	Tetramethylthiuram disulphide (75%)	E. I. du Pont de Nemours & Co. (Inc.)
Arquad C	Dialkyl dimethylammonium chloride	Armour and Co.
Arquad 2 HT	Dialkyl dimethylammonium chloride	Armour and Co.
Basic copper carbonate	"Fixed" or "insoluble" copper	Tennessee Corp.
Bionol A	Alkyl dimethyl benzyl ammonium chloride	General Dyestuff Co.
Bioquin-1	Copper 8-quinolinolate	Monsanto Chem. Co.
BTC	Alkyl dimethyl benzyl ammonium chloride	Onyx Oil & Chem. Co.
C & C L-224	Mercury-zinc-chromate	Carbide & Carbon Chem. Co.
C & C L-640	Copper-zinc-chromate	Carbide & Carbon Chem. Co.
C & C 5400	Reaction product of dimethyldithiocarbamate and sulfur dichloride	Carbide & Carbon Chem. Co.
Ceresan M	Ethyl mercury p-toluene sulfonanilide	E. I. du Pont de Nemours & Co. (Inc.)
Cop-O-Zink	Tribasic copper sulfate & zinc sulfate	Tennessee Corp.
Cuprocide (yellow)	Yellow copper oxide (.075%)	Rohm and Haas
Dithane D-14	Disodium ethylene bisdithiocarbamate	Rohm and Haas
Dithane Z-78	Zinc ethylene bisdithiocarbamate	Rohm and Haas
Dow 9B	Zinc 2,4,5 trichlorophenate (50%)	Dow Chemical Co.
Dynacide	Phenyl mercuric acetate (5%)	O. E. Link Co., Inc.
Emcol 888	Quarternary ammonium compound	The Emulsol Corp.
New Improved Ceresan	Ethyl mercury phosphate (5%)	E. I. du Pont de Nemours & Co. (Inc.)
Octab	Octadecyl dimethyl benzyl ammonium chloride	Fairfield Laboratories
Onyxide	Octadecenyl dimethyl ammonium chloride	Onyx Oil & Chem. Co.
Orthocide 406	N-trichloromethylthio tetrahydrophthalimide	Calif. Spray-Chem. Corp.
Panogen S	Copper 8-quinolinolate	Panogen Inc.
Panogen	Methyl mercury dicyan diamide in oil	Panogen Inc.
Phygon	2,3-dichloro-1, 4-naphthoquinone	U. S. Rubber Co.
Phygon XL	2,3-dichloro-1, 4-naphthoquinone	U. S. Rubber Co.
Puratized C-12-2525	Organic mercury-cadmium compounds	Gallowhur Chem. Corp.

TABLE 1—Continued

Trade or code name	Active principle	Source
Puratized C-13-1212	Organic mercury-cadmium compounds	Gallowhur Chem. Corp.
Puratized C-15-1212	Organic mercury-cadmium compounds	Gallowhur Chem. Corp.
Puratized N5ST	Organic mercury compound	Gallowhur Chem. Corp.
Puratized BST	Organic mercury compound	Gallowhur Chem. Corp.
Puratized 177	Organic cadmium compound	Gallowhur Chem. Corp.
Puratized SC	Organic mercury compound	Gallowhur Chem. Corp.
Puratized SPC	Organic mercury compound	Gallowhur Chem. Corp.
Puratized 601	Organic mercury compound	Gallowhur Chem. Corp.
Puratized 641	Organic mercury compound	Gallowhur Chem. Corp.
Quarternary O	High mol. wt. imidazolium chloride	Alrose Chem. Co.
Seedox	2,4,5-trichlorophenyl acetate (50%)	R. J. Prentiss Co.
Semesan	Hydroxymercurichlorophenol (30%)	E. I. du Pont de Nemours & Co. (Inc.)
Spergon (Chloranil)	Tetrachloro-p-benzoquinone (96%)	U. S. Rubber Co.
Spergon (Wettable) do	Tetrachloro-p-benzoquinone (48%)	U. S. Rubber Co.
Tribasic copper sulfate	"Fixed" or " insoluble" copper	Tennessee Corp.
Vancide 51	Sodium salts of dimethyl dithio-carbamic acid and 2-mercaptobenzothiazole	R. T. Vanderbilt Corp.

or of water were added to and mixed with the chemical in a flask until a thick slurry was obtained. The seed was added to the flask and the flask rotated until the seed was thoroughly covered and fairly dry. Final drying was accomplished in a few minutes in the open on paper toweling. The dry treatments were made by adding the chemical to the seed in a flask and rotating the flask until complete coverage was attained. All the experiments were designed to facilitate statistical analysis of the data.

The results obtained from the studies involving a comparison of dry and slurry methods of seed treatment have been presented in earlier publications (1, 2).

CHEMICAL SEED TREATMENT COMPARISONS

The results from the seed treatment studies comparing the efficacy of the various seed treatment chemicals are summarized in Tables 2, 3,

TABLE 2—Average stands of Little Marvel pea in 1949 after seed treatment with fungicides to prevent damping-off

Trade or code name†	Average stand‡
	Number
Phygon§	95.0*
Puratized 601	86.8
Semesan	85.8
Ceresan M	85.5
New Improved Ceresan	79.2
Puratized SPC	78.8
Yellow Cuprocide	78.5
C & C L-224	77.0
Bioquin-1	76.8
Puratized N5ST	75.5
Puratized 641	75.5
Spergon	75.5
Arasan	74.8
Puratized BST	74.5
C & C L-640	70.0
Dow 9B	70.0
Puratized 177	69.5
Dithane Z-78	67.5
Puratized SC	66.5
Non-treated control	75.8
L. S. D.—5-percent level	18.0

*Significance at the 5-percent level indicated by asterisk.

†All fungicides applied to seed at rate of 2 oz./100 lb. of seed except New Improved Ceresan, Yellow cuprocide, and Spergon, which were applied at ½, 4, and 4 oz./100 lb. of seed respectively.

‡Average stand in four replicated plots; 150 seeds planted per plot.

§In later tests Phygon XL.

TABLE 3—Average stands of Alderman and Little Marvel peas in 1950 after seed treatment with fungicides to prevent damping-off

Trade or code name*	Average stand†		
	Alderman	Little Marvel	Combined ave.
	Number	Number	Number
Phygon XL	105.8	96.2	101.0
C & C L-640	100.0	71.5	85.6
C & C L-224	98.8	83.0	90.9
Ceresan M	97.2	84.6	91.0
Panogen	96.0	98.2	97.1
Yellow cuprocide	91.2	75.0	83.1
Bioquin-1	78.8	71.6	75.2
Arasan	71.5	77.2	74.3
Panogen S	52.2	49.8	51.0
C & C 5400	52.0	65.2	58.9
Spergon	47.8	48.2	48.0
Non-treated control	48.2	45.8	47.0
L. S. D.: 5-percent level	18.6	15.8	11.8
1-percent level	25.1	21.3	15.7

*Except for Phygon XL and Spergon, which were applied at 4 oz./100 lb. of seed, and the Panogen liquid compounds, which were applied to the seed at 0.2 percent of the seed weight, a standard dosage of 2 oz./100 lb. of the chemicals was applied to the seed.

†Average stand of four replicated plots; 150 seeds planted per plot.

and 4. Although there were no significant differences between most of the fungicides and the non-treated control in 1949, the chemicals are listed so that they may be compared with the results obtained in 1950 and 1951.

Several fungicides were very effective in controlling damping-off, but Phygon XL or Phygon was the best over the 3-year period. Semesan, used in 1949 and 1951, ranked next to Phygon XL as a seed treatment material for peas. Ceresan M (dry), Arasan, Arasan SF, C & C L-640, C & C L-224, and Panogen were very effective in one or two years and relatively ineffective in other years. Puratized 601, Agrox, Puratized C-12-2525, and Orthocide 406 were very effective but, since they have been tested only once, further tests are necessary before general comparisons can be made with the more thoroughly tested materials. Spergon, which is generally recommended for pea seed treatment (5), was relatively ineffective in these tests. However, in the slurry experiments (Table 5), Spergon appeared nearly as effective as Phygon XL for the control of damping-off on Alaska and Little Marvel peas but not on Wisconsin Perfection.

TABLE 4—Average stands of Alderman pea in 1951 after seed treatment with various chemical protectants to prevent damping-off

Trade or code name*	Physical form	Average stand†
		Number
Agrox	powder	109.8
Phygon XL	powder	106.5
Semesan	powder	103.2
Puratized C-12-2525	powder	102.6
Orthocide 406	powder	102.3
Arasan SF	powder	101.2
Puratized C-15-1212	powder	100.3
C & C L-640	powder	99.0
Arasan	powder	98.8
C & C 5400	powder	97.3
C & C L-224	powder	96.5
Dithane D-14	powder	95.7
Puratized C-13-1212	powder	94.5
Vancide 51	liquid	94.2
Cop-O-Zink	powder	93.8
Ceresan M	powder	91.8
Quarternary O	paste	91.0
Dynacide	powder	90.6
Basic copper carbonate	powder	90.6
Arquad 2HT	paste	88.5
Onyxide	paste	87.6
Panogen	liquid	87.3
Arquad C	liquid	87.0
Amine S	solid	86.0
Octab	powder	83.7
Seedox	powder	81.5
Emcol 888	liquid	78.5
Bionol A	liquid	71.5
BTC	paste	56.6
Non-treated control		84.6
L. S. D.: 5-percent level		9.0
1-percent level		11.0

*All chemicals applied at a rate of 4 oz./100 lb. of seed except Agrox, Semesan, Dynacide, C-13-1212, C-15-1212, and C-12-2525, which were applied at 2 oz., Arasan SF at 3 oz., and Phygon XL at 3½ oz./100 lb. seed. Panogen was applied at 0.2 percent of the seed weight.

†Average stand of six replicated plots: 150 seeds planted in each plot.

SLURRY VERSUS DRY TREATMENTS

Since the slurry method of seed treatment is gradually replacing the dry method, several experiments were made to compare these two methods of application (Table 5). These results indicated that Phygon XL was just as effective in the dry as the wet form. On the other hand, Arasan and Spergon were better in the slurry form than in the dry when applied to the variety Wisconsin Perfection in 1949 but not when

TABLE 5—Comparison of the dry and methocel slurry methods of seed treatment on a percentage emergence basis with several pea varieties, 1949-51

Variety or Dosage	Year	Stand after treatment with indicated fungicide									
		Phygon XL		Arasan*		Spergon		Ceresan M		Control	
		Dry	Slurry	Dry	Slurry	Dry	Slurry	Dry	Slurry	Dry	Slurry
		Percent									
Alaska.....	1949	94	94	96	95	95	96	94	95	91	91
Wisconsin Perfection..	1949	64	67	45	57	44	53	57	70	37	38
Alaska.....	1950	90	92	..	..	..	..	91	35	85	84
Alderman....	1950	77	78	..	..	..	..	75	66	32	25
Little Marvel.	1951	77	72	67	69	70	73	66	31	67	..
Fungicide dosage in (oz./100 lb. seed)	1949	1 ½	1 ½	2	2	3	3	1 ½	1 ½	..	..
	1950	4	4	..	..	..	..	4	4	..	..
	1951	4	4	4	3	4	4	2	2	..	..

*Arasan (50%) used for dry treatments and Arasan SF (75%) for the slurry treatments.

applied to the variety Little Marvel in 1951. Ceresan M slurry was better on Wisconsin Perfection in 1949 than dry Ceresan M, but injured Alaska, Alderman, and Little Marvel varieties in 1950 or 1951. Thus Ceresan M cannot be recommended for use in slurry treatments. A more detailed report on the effects of Ceresan M on peas has already been made (1, 2).

The foregoing results and comparisons were made between dry and Methocel slurry applications of the chemicals (Table 5). Included in some of the tests were water slurry treatments. In general, there were no significant differences between the water and the Methocel slurry treatments. Theoretically, the advantage gained by using the Methocel instead of the water slurry would be that of better adhesion of the material, which would allow for freer handling of the seed after drying.

DISCUSSION

The results of these studies can best be compared with those reported by other field stations on the seed treatment of peas (3, 4, 5, 6, 7). For example, in nation-wide fungicide tests of 1948 (6), Idaho listed Phygon, Arasan, and Spergon as being the best for the control

of seed decay and damping-off in Thomas Laxton peas. In Pennsylvania, C & C "A", tribasic copper sulfate, Spergon, and Arasan were rated in that order for Laxton Progress peas. In Mississippi, the order of effectiveness in increasing yields was Spergon, Fermate, Ceresan M, Phygon, and Arasan SF. In South Carolina, Phygon XL, Semesan, Arasan, Ceresan M, Spergon, Dow 9B, and Seedox all gave highly significant increases in emergence. In 1949 (7), Maryland rated Arasan and Spergon as being the best for the Pride peas, and Wisconsin mentioned a new product (KF 467) as the best for damping-off control: this was followed by Phygon, Spergon, Arasan, Dow 9B, and Phygon XL. In a cooperative experiment in four states, C & C L-640 was rated best for emergence and C & C L-224 second. McCallan (4) stated that C & C L-640 and C & C L-224 were significantly better than Thiram (Arasan) and C & C 5400 and that the last two chemicals were significantly better than the controls in tests conducted at five stations and in the greenhouse. Hagedorn (3), reporting on results for the years 1949 and 1950, stated that Arasan, KF 467, Phygon and Spergon were significantly more effective than Arasan SF, Dow 9B, or Phygon XL. Using greater dosages in 1951, he showed that KF 467 and Phygon were the best seed protectants.

An examination of the results reported by other workers, together with those obtained at this station, indicated considerable variation in the effectiveness of the various fungicides at different stations and even in different years at the same station. Possibly this can be attributed to various degrees of severity of damping-off, a factor associated with the soil environment at the time of planting. Varieties also respond differently to the various seed treatment chemicals. Furthermore, there may have been different methods and rates of application at the various stations. Results at this station and those obtained by Hagedorn (3) in Wisconsin show the importance of these factors.

SUMMARY AND CONCLUSIONS

Although varieties differ greatly in their degree of susceptibility to damping-off and seed decay, the practice of seed treating is recommended to help the grower obtain the best stand and yield possible.

Several fungicides were found to be effective seed protectants for peas. Of these, Phygon XL, Phygon, and Semesan were the best protectants. Ceresan M, Arasan, Arasan SF, C & C L-640, C & C L-224, and Panogen were good in some seasons. Those fungicides which were

tried one season only and found to be very effective (Agrox, Puratized 601 and C-12-2525, and Orthocide 406) will be tested more extensively this coming season if they are still available.

Comparisons made between dry and slurry methods of seed treatment indicated that either the slurry or the dry method was satisfactory and that water and Methocel slurries were equally effective.

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SOME EFFECTS OF BRUSHING AND SULFUR DUSTING OF PEACHES ON DECAY AND SHRIVELING

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BRUSHING PEACHES removes objectionable pubescence, but information on the effect of this operation on the entrance of decay organisms is meager.

Smith[2] reported on a 36-hour shipment of peaches by iced refrigerator car from Centralia, Illinois, to Pittsburg, Kansas, in 1928. The test indicated that peaches that were brushed but not given fungicidal protection had 8.90 percent brown-rot infection, but those which were brushed and dusted with sulfur had only 3.98 percent decay. The best control in that trial was 3.58 percent where unbrushed fruit was dusted with sulfur.

In a study published in 1932, Dorsey and Potter[3] state "From these studies it is quite evident that the brushing operation seldom injures the surface of a hard-ripe fruit." They conclude "In the final analysis brushing must be evaluated in terms of the kind of surface left by the process. It is evident that changes due to brushing consist primarily in (a) removal of the longer hairs, and (b) in the exposure of surfaces where the hairs were broken off."

In 1949, experiments were made in cooperation with the Coloma Fruit Exchange, Coloma, Michigan, the National Association of Ice Industries, Inc., Washington, D. C., and the Food Machinery and Chemical Corporation, John Bean Division, Lansing, Michigan.

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ARTICLE 35-5

METHOD OF PROCEDURE

The peaches used came from one orchard and comprised fruit of one fractional picking period. Treatments were conducted as follows:

1. Brushing in a clean brusher without benefit of a fungicide.

1-A. Brushing, followed by "Stericooling" with sodium hypochlorite at 1530 p.p.m. available chlorine in 32°F. ice-water for 30 minutes.

2. Brushing and treating peaches with dusting surfur.

2-A. "Stericooling" brushed and sulfur-dusted peaches, using sodium hypochlorite at 1530 p.p.m. available chlorine in 32°F. ice-water for 30 minutes.

3. Check, unbrushed and untreated peaches.

3-A. "Stericooling" peaches that were not brushed or dusted with dusting sulfur, but which were treated with sodium hypochlorite at 1530 p.p.m. available chlorine in 32°F. ice-water for 30 minutes.

Treatments were concluded within 14 hours of the time the fruit was picked. The average of 40 pressure tests indicated a firmness of 12.55 pounds.

All of the fruit was placed at a temperature of 75°-85°F. to ripen and hasten effects of the treatment. Twelve days after treatment the results were tabulated, as shown in Table 1. There were 2,171 peaches in this test.

RESULTS OF BRUSHING ON TREATMENTS AND DECAY

Brushing in a clean mechanical brushing unit (Table 1, Treatment 2) resulted in 17.91 percent less decay than when samples were unbrushed (Treatment 1). Still better control was demonstrated when dusting sulfur was blown onto the peaches as they were being "defuzzed" (Treatment 3), as illustrated in Fig. 1.

Treatments 4, 5 and 6 indicate that "Stericooling" with 1530 p.p.m. available chlorine considerably reduced the effect of decay organisms for 12 days after the fruit was harvested and treated. Treatment number 6 was the only exception and shows 4.52 percent more spoilage than Treatment 3, but is well below the checks (Treatments 1 and 4).

Fig. 1. This picture illustrates the type of equipment used in hydrocooling with chlorinated ice-water in a "Stericooler", as described in the tests conducted in 1949 at the Coloma Fruit Exchange, Coloma, Michigan. An identical machine has been in operation for five years at the Millburg Growers Exchange, Millburg Station, Benton Harbor, Michigan.

Since "Stericooling" (illustrated in Fig. 2) is becoming an accepted practice, a stericooled lot was included in these trials for comparison. If one may assume that chilling at 32°F. in no way makes the peach more resistant to decay, the reduction in spoilage may then be credited to the fungicidal action of sodium hypochlorite added to the ice-water, since no further refrigeration was used.

TREATMENT IN RELATION TO SHRIVELING

Several days after the treatments were made it was very noticeable that the brushed and the sulfur-dusted lots were shriveling more rapidly than the untreated fruit used as a check. Since the objective was to test materials that might retard decay, the peaches in this experiment were not weighed. Hence, at the time spoilage counts were made each sound fruit was rated as to "light," "medium" or "heavy" degree of shriveling or skin wrinkling.

As might be expected, the unbrushed fruit showed the least amount of shriveling and most of the unbrushed specimens showed no visual sign of water loss. Only by pressing the skin between thumb and finger could shriveling be detected and, hence, was classified as "light" shriveling.

Brushing greatly increased the amount and severity of shriveling of the skin.

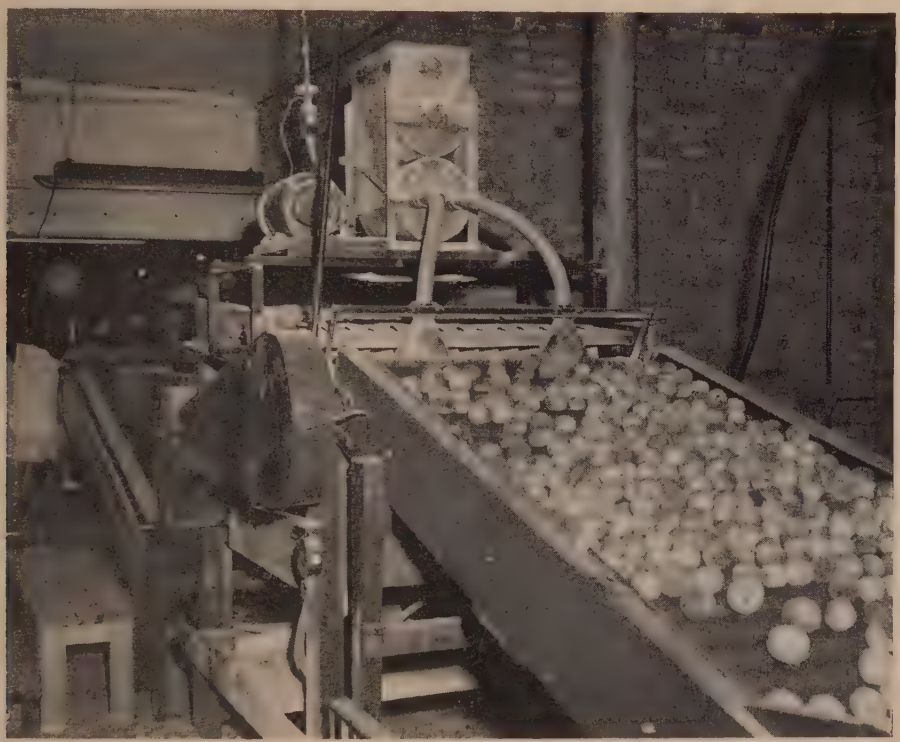

Fig. 2. In this scene peaches are being conveyed to the brushing and cleaning unit. The hopper on top of the "brusher" holds the dusting sulfur, which is blown through the two tubes and the dry fungicide is drawn over the peaches as they are being "defuzzed." This treatment, which gave satisfactory results in these tests seems to increase water loss from unrefrigerated fruit, as measured by degree of skin shriveling. The less mature fruit showed the most shriveling when dusted with sulfur and allowed to ripen without refrigeration.

Dusting brushed fruit with dusting sulfur, as is practiced in many peach packing houses, produces the greatest percentage of "medium" to "heavy" shriveling.

Although dusting sulfur (Table 1, Treatment 3) greatly increased shriveling, "Stericooling" after the fruit had been previously brushed

TABLE 1—Effect of brushing and dusting Elberta peaches on treatment, decay and shriveling

Determinations made 12 days after treatment and 14 days after harvest.

Treatment	Decay	Shriveling		
	Decayed fruit	Light	Medium	Heavy
	(percent)	*(percent)*	*(percent)*	*(percent)*
1. Unbrushed, untreated check.	48.29	99.35	0.64	000
2. Brushed only.....	30.38	76.18	20.94	2.87
3. Brushed and dusted with sulfur.....	20.82	51.28	37.47	11.24
Effect of "Stericooling" on treatment, decay and shriveling				
4. Unbrushed, Stericooled check	38.88	96.52	3.47	000
5. Brushed and Stericooled.....	10.55	76.47	16.17	7.35
6. Brushed, dusted and Stericooled.....	25.34	71.21	19.81	8.96

Fruit examined: 2,171 peaches.

and dusted did not reduce spoilage or shriveling as much as when brushing alone had preceeded "Stericooling".

These tests were conducted without benefit of subsequent refrigeration and high relative humidity. All fruit was held at 75°-85 F. until decay was in evidence.

Mechanical brushing of Elberta peaches to remove the pubescence resulted in slightly less decay and more shriveling than when similar fruit was not brushed.

Brushing and dusting with dusting sulfur reduced loss from decay as compared with brushing alone or no brushing.

Dusting peaches with sulfur markedly increased the severity of shriveling as compared with brushing and no brushing.

Hydrocooling and treating with sodium hypochlorite in the "Stericooler" machine improved the control of decay and shriveling of peaches.

With fruit that had previously been brushed and treated with dusting sulfur, hydrocooling and treating with sodium hypochlorite in a "Stericooler", did not reduce decay or shriveling as much as when peaches were brushed but not treated with sulfur.

POST HARVEST TESTS WITH PEACHES TO REDUCE SPOILAGE

A Progress Report on Trials to Improve Market Quality of Peaches

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The most serious problem in marketing peaches is that of unsatisfactory maturity. More often immature and mature fruit is mixed in the same package. The next most serious problem for shipper and buyer is that of loss due to peach-rotting organisms. Often this loss is the result of bruising of the most mature specimens.

Usually extreme differences exist in the manner in which fruit holds up against loss from spoilage. This variation shows up between many refrigerated lots, within nearly every unrefrigerated lot and within many packages of peaches on the retail market.

In a recent study of Michigan peaches (4), the problem was stated thus:

"The variation in waste reported by buyers of both Halehaven and Elberta peaches showed a wide variation. Almost two-fifths of the buyers reported less than one pound of waste per bushel due to rot. On the other hand, one-fifth reported 20 percent or more waste due to rot. Such wide variation in waste due to rot suggests the need for more information concerning methods now used for controlling rot. If one-third of the peaches can be marketed with no more rot than one pound per bushel it should be possible for more to be as successfully grown and handled by the same methods."

The challenge is to find the successful methods.

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ARTICLE 35-6

In a 1947 market study, Cravens and Mauch (3) reported: "The fact that about 60 per cent of the rots recorded in retail store tests were at the stem-end indicates a possibility that the weakest link in rot control is during the period immediately after harvest when the infection apparently enters the peach through a picking injury. It is usually easier and safer to prevent an infection than to allow infection

Fig. 1. Michigan peaches are shown after completing their treatment through a shower of chlorinated ice-water at the Coloma Fruit Exchange, Coloma, Michigan. After protective pad and cover is applied, they are ready to be placed in refrigerated car, truck or storage room.

to develop and then attempt to stop its growth. This would mean more prompt treatment for rot control after picking. Because of the rapid rate of spread of these rots, this may mean treatment within an hour or two instead of after the common overnight wait."

The trials[3] outlined for the 1949 season were made for the purpose of throwing some light on certain of those conditions.

[3]These tests were conducted through the cooperative efforts of the Food Machinery and Chemical Corporation, John Bean Division, Lansing, Michigan, the National Association of Ice Industries, Washington, D. C., and the Coloma Fruit Exchange, Coloma, Michigan.

EXPERIMENTS CONDUCTED

Three phases of trials to test effectiveness of certain promising safe fungicides were made:

Part I. Time lapse between picking and treatment as related to peach decay.

Part II. Peach maturity as a factor in decay control.

Part III. Place of entrance of decay organisms as related to treatment.

All the fruit in these trials came from one orchard of 14-year-old Elberta peach trees.

No sign of brown-rot was noted on the trees in this orchard. In sorting fruit before treatment, to remove injured, deformed or over-ripe specimens, no visible sign of infection was detected.

Fruit of the first fractional picking of Elberta peach trees was used in the first phase of these trials, as follows:

PART I. TIME LAPSE BETWEEN PICKING AND TREATMENT AS RELATED TO PEACH DECAY

(PART I) PROCEDURE

a) Approximately a third of the picking was treated by dipping or dusting by hand in the orchard, by means of a cloth dipped in dusting-sulfur, within 3 hours of the time picking started. The treated fruit was hauled to the packing house and placed at 75° F. average air temperature on the packing house floor.

b) The untreated fruit of that picking was hauled to the packing-house and placed in cold-storage at 32 F. for subsequent treatments.

c) Eighteen hours after harvest about one-third of the fruit was sorted into 15-pound "Jumbo" baskets and given the same series of treatments and placed on the floor at 75° F.

d) Twenty-nine hours after picking, the remaining fruit in cold storage was given the series of treatments and placed alongside the other treatments at 75° F.

In the treatments involving submerging of the fruit in liquid, new, sterilized 30-pound frozen-food cans were used. Twenty-five pounds

of tap-water was weighed into each container and the chemical fungicide was added.

Peaches were placed in each chemical solution until liquid reached the top. Placing the cover held the top fruit submerged. Each lot was soaked for 15 minutes, removed and placed in new wooden 15-pound grape-type baskets, and the containers were again filled with peaches.

As in the experiments reported by Haller (5) and Haller, Smith, Wright and Womeldorph (6), dusting sulfur was applied by hand using a cloth dipped in dusting sulfur.

Fig. 2. A side view of the installation used to precool and treat peaches at the Coloma Fruit Exchange. The assembly is convenient to railroad siding as well as to the cold storage rooms in the basement.

(PART I) RESULTS

Seven days after harvest the fruit of all the treatments was examined for decay, as shown in Table 1. No attempt was made to determine what organism caused the decay. Haller (5) has indicated brown-rot and rhizopus are equally serious on harvested peaches.

TABLE 1—Time lapse between harvest and treatment as effecting decay

Treatments made within 3 hours, 18 hours, and 29 hours of harvest
First fractional picking, September 1, 1949, Elberta trees 14 years of age
Fruit held at 70°-80° F. for seven days before loss from rot was determined

Treatment	Time lapse between harvest and treatments of Elberta peaches								
	Three hours			Eighteen hours			Twenty-nine hours		
Average pressure test—15.66 lb.	Fruit decayed	Fruit decayed	Total fruit	Fruit decayed	Fruit decayed	Total fruit	Fruit decayed	Fruit decayed	Total fruit
	(*number*)	(*percent*)	(*number*)	(*number*)	(*percent*)	(*number*)	(*number*)	(*percent*)	(*number*)
A. Untreated check	31	28.44	109	2	2.15	93	3	5.17	58
B. Dusting sulfur	2	1.86	107	6	6.81	88	10	20.00	50
C. Sodium hypochlorite at 200 p.p.m.	4	3.55	112	15	14.70	102	7	13.72	51
D. Sodium hypochlorite at 500 p.p.m.	5	4.03	124	7	7.44	94	5	9.80	51
E. DHA-S* at 0.1 percent	8	7.61	105	7	6.92	101	4	6.66	60
F. 8-Quinolinolin at 0.02 percent	3	2.72	110	7	6.53	107	2	3.84	52
G. 8-Quinolinolin at 0.03 percent	17	14.65	116	23	23.70	97	10	16.94	59
H. N. But. Vanillate at 0.02 percent	17	15.04	113	22	22.22	99	10	18.51	54
I. N. But. Vanillate at 0.03 percent	9	8.48	106	6	6.31	95	6	9.66	62

L. S. D. 5% level=11.92

*DHA-S designates a sodium salt of dehydroacetic acid.

The greatest amount of infection occurred in the untreated fruit used as a check for the treatments made in the orchard within 3 hours of harvest. Obviously, this fruit was not refrigerated before treatment, whereas the fruit for the later treatments was precooled before treatment.

The fruit was left at room temperature for 7 days after harvest without handling and the determination shown in Table 1, were made.

Infection of untreated check-fruit used for the two later treatments showed much less decay and was less than all but one of the treated lots. As for this 1-year trial, it would seem from the check lots in Table 1, that precooling under mechanical refrigeration, even for 18 and 29 hours after harvest, inhibited decay after removal from cold storage. All of the so-called fungicides selected for these trials showed promising reduction of infection, when treatment was made within 3 hours of harvest.

In the can-dipping trials sodium hypochlorite used at 200 p.p.m. available chlorine was more effective with fruit treated within 3 hours of harvest than with delayed treatments. When used at 500 p.p.m. delayed treatments seemed somewhat more effective than for 200 p.p.m. The same was true for DHA-S[4] at 0.1 percent, 8-Quinolinolin at 0.02 percent and for normal butyl vanillate at 0.03 percent. On the other hand, 8-Quinolinolin at 0.03 percent and N. But. vanillate at 0.02 percent resulted in the poorest prevention of decay in all three periods of treatment.

Dusting sulfur was very effective in treatments given within 3 hours of harvest but seemed to be less effective with the lots treated at later intervals.

The Elberta peaches used in this experiment represent 18 bushels of orchard-run fruit of the first fractional picking from four 14-year-old trees in one orchard. Within 3 hours of harvest about one-third of the fruit was divided for nine duplicate treatments. The treated fruit was placed on the packing house floor to ripen for 7 days after harvest before determining the amount of decay. The average of 40 pressure-test readings showed the fruit to have a peeled flesh-firmness of 15.66 pounds. It was "hard" to "firm" maturity.

Statistical analysis of variance indicates (Table 1) that the fruit treated against rots within 3 hours after harvest showed some significant differences as to the ability of certain treatments to retard spoilage loss. Treatments A (check), G (8-Quinolinolin at 0.03 percent), and

[4]DHA-S designates a sodium salt of dehydroacetic acid.

H (Normal Butyl Vanillate at 0.02 percent) resulted in much higher percentages of decay than did treatments B, (dusting sulfur), C (sodium hypochlorite at 200 p.p.m.), D (sodium hypochlorite at 500 p.p.m.) and F (8-Quinolinolin at 0.02 percent). The analysis also shows that the percentage of decay in the untreated check, A, was much greater than with fruit that was treated with DHA-S at 0.1 percent (Treatment I).

The two series treated 18 and 29 hours after harvest showed no significant differences between treatments.

The great amount of split-pit in cold storage caused the third series to be reduced to one lot per treatment before starting the 29-hour lot.

The combined analysis of variance for all the fruit of Table 1, indicates that the fruit given treatments G and H had more decay than did that given treatments B, C, D, E, F, and I. It also shows that fruit which received treatment A (check) had more spoilage than did the peaches given treatment F (8-Quinolinolin at 0.02 percent).

An examination of 1,375 peaches used in this trial revealed that the fungicides were quite effective in reducing peach rots, especially when used within a few hours after harvest.

This trial seems to bear out the market study by Cravens and Mauch (3), that, "It is usually easier and safer to prevent an infection than to allow infection to develop and then attempt to stop its growth. This would mean more prompt treatment for rot control after picking."

Only a very small part of Michigan's peach crop is either treated or refrigerated adequately within 18 to 29 hours after the fruit is picked. This may well be the weakest link in the marketing of such perishable produce.

It is interesting to note that 8-Quinolinolin used at 0.02 percent was consistently one of the best but when used at 0.03 percent poorer control resulted (Table 1).

PART II. PEACH MATURITY AS A FACTOR IN DECAY CONTROL

In previous reports (1, 2) of attempts in Michigan to reduce spoilage of harvested peaches, most of the treatments were made with commercially packed fruit in several packing houses. The fruit had been brushed to remove the pubescence, and at the same time it was treated with dusting sulfur to retard the growth of rotting organisms. Any subsequent treatments were evaluated against brushed and sulfur treated checks. These 1949 treatments were all made on unbrushed

fruit. The fruit for this test was harvested between 7 and 9 a. m. September 4, and was placed as soon as possible in cold storage at the Coloma Fruit Exchange. The fruit was sorted inside the cold storage into two lots of two different degrees of maturity (Table 2).

(PART II) PROCEDURE

The fruit was separated on the basis of its under-color. All specimens showing no trace of lemon-yellow were classified as "hard-ripe," and peaches showing some lemon-yellow were classified as "firm-ripe."

Fig. 3. In a retired refrigerator car, shown at the left in Fig. 2, block water-ice is stored for use in this type of precooling equipment. From an ice-crusher in the car, crushed ice is conveyed to the "Stericooler."

The latter group also showed the most red surface coloration. The fruit was placed in duplicate lots, using new "Jumbo" grape baskets. After separating the sound fruit into two grades of color, pressure tests were made on the peeled flesh of 10 peaches from each lot, using a 5/16-inch point on a Ballauf pressure tester. Two readings were taken on either side of the suture and two on the side of the peach. The

average of 40 pressure tests on the "hard" fruit was 16.20 pounds, and the 40 tests made on "firm" fruit averaged 13.25 pounds. Analysis of variance shows that the average of the readings on "hard" fruit is significantly smaller than the average of "firm" fruit.

The fruit was subjected to nine treatments as shown in Table 2. Besides the untreated checks, one lot was given a liberal coating of

TABLE 2—Post-harvest maturity of Elberta peaches in relation to treatment and decay

Unbrushed fruit of the first fractional harvest from one orchard. Held 10 days at 75° F. All sodium hypochlorite treatments were made in a pilot "Stericooler."

	Decayed fruit (*number*)	Decayed fruit (*percent*)	Total fruit examined
Part I: Green mature ("hard-ripe") with green undercolor			
A. Untreated check	21	13.54	155
B. Dusting-sulfur	14	9.03	155
C. Sodium hypochlorite* at 2,000 p.p.m.	47	29.75	158
D. Sodium hypochlorite* at 1,000 p.p.m.	8	4.34	184
E. Sodium hypochlorite* at 750 p.p.m.	12	7.01	171
F. Sodium hypochlorite* at 520 p.p.m.	15	9.93	151
G. Sodium hypochlorite* at 320 p.p.m.	19	14.61	130
H. Sodium hypochlorite* at 120 p.p.m.	22	15.06	146
I. "Sta-Fresh"†	14	9.79	143

Average of 40 pressure tests at time of treatment was 16.2 pounds.
Test for analysis of variance indicates no significant difference between treatments.

Part II: Yellow mature ("firm-ripe") with lemon yellow undercolor			
A. Untreated check	53	48.61	109
B. Dusting sulfur	8	6.15	130
C. Sodium hypochlorite* at 2,000 p.p.m.	53	37.58	141
D. Sodium hypochlorite* at 1,000 p.p.m.	12	8.08	132
E. Sodium hypochlorite* at 750 p.p.m.	26	16.87	154
F. Sodium hypochlorite* at 520 p.p.m.	22	15.06	146
G. Sodium hypochlorite* at 320 p.p.m.	14	8.85	158
H. Sodium hypochlorite* at 120 p.p.m.	24	16.32	147
I. "Sta-Fresh"†	16	10.88	147

L.S.D. 5% level=15.61.
Average of 40 pressure tests at time of treatment was 13.25 pounds.

*"Hypo-Clor", brand of sodium hypochlorite was used.

†"Sta-Fresh" is a brand of fungicidal wax emulsion distributed by Food Machinery and Chemical Corporation. One part of "Sta-Fresh" was used in two parts of tap-water. Because of limited quantity this treatment was made by dipping.

dusting sulfur. Six lots were treated in a "Stericooler"[5] at different dilutions of a recommended fungicide (sodium hypochlorite), and one lot was dipped for 15 minutes in a fungicidal wax emulsion.

As a fungicide, sodium hypochlorite was added to the ice water and each lot was given a 15-minute drench. The strength of the fungicide was increased for each subsequent lot of fruit, using 120, 320, 520, 750, 1,000 and 2,000 p.p.m. available chlorine as determined by frequent titration tests. The baskets of fruit thus treated were placed on the packing house floor and stored at an average air temperature of 75° F. for 10 days, when 2,657 peaches were examined for rot.

(PART II) RESULTS

Analysis of variance indicates that the peaches harvested at a green ground color stage, as shown in Table 2, Part I, showed no significant difference between treatments.

The fruit that had light lemon yellow ground color when harvested (Table 2, Part II) showed some significant differences between certain treatments in ability to inhibit rotting organisms for 10 days after treatment.

Analysis of variance of Table 2, Part II, indicates:

1. That the unbrushed, untreated check, A, showed significantly more loss from rots than did treatments B, D, E, F, G, H, and I.

2. That treatment C showed significantly more decay than treatments B, D, E, F, G, H, and I.

3. That treatments A (check) and C (2000 p.p.m.) were not significantly different and the fruit were severely attacked by rotting organisms.

4. That there was no significant difference between treatments B, D, E, F, G, H, and I.

Based on the conditions of the 1949 season, it appears that sodium hypochlorite at 1000 p.p.m. available chlorine was significantly superior to lesser dilutions as well as to treatments B (dusting sulfur) and I (fungicidal wax emulsion).

This trial considered only market-type losses from spoilage of peaches from rot-causing organisms. From that viewpoint, the results strongly illustrate why those who buy peaches for distant shipment or for cold storage prefer the fruit to be picked on the hard, green side

[5]The "Stericooler" is a patented name of a hydrocooling machine in which a fungicide may be used in the ice-water, as illustrated in Fig. 2.

of maturity. It also indicates that if "firm-ripe" to "ripe" fruit is to be profitably marketed it must be precooled and, perhaps, should be treated with an effective fungicide. It should also be held under adequate refrigeration until it reaches the retail distributor. Untreated fruit of "hard-ripe" maturity resulted in only 13.54 percent infection in the 10-day period.

These preliminary trials indicate that sodium hypochlorite, used in 32° F. ice water, at a dilution of 2000 p.p.m. set up a condition favorable to the entrance of peach-rotting organisms, whether the fruit was picked "hard" or "firm" mature. At 1000 p.p.m. the same fungicide gave the best control when this chlorine compound was used.

PART III. PLACE OF ENTRANCE OF DECAY ORGANISMS AS RELATED TO TREATMENT

The prevalence of peach decay originating at the stem-end of the fruit has been previously reported (1, 3). In recording the number of infected fruits of all the treatments, the place of entrance of the organisms was also recorded.

The place of entrance of decay of a number of representative treatments is shown in Table 3.

The tearing of tissue as the fruit is removed from the twig appears to be the reason for the preponderance of infection in that area.

SUMMARY

Elberta peaches from one orchard were used for experiments in an attempt to compare the effectiveness of certain promising fungicides in the control of post-harvest decay.

The effect of time of treatment made within 3, 18 and 29 hours of harvest was studied. All the selected treatments made within 3 hours of harvest showed promising reduction of decay.

An attempt was made to determine the effect of fruit maturity as related to the treatment employed. Analysis of variance indicates that there was no significant difference between treatments on less mature ("hard-ripe") fruit. In the case of "firm-ripe" maturity, certain treatments were significantly different and promising.

The stem-end of the fruit was found to be the most vulnerable place for the entrance of post-harvest rots.

TABLE 3—Decay of Elberta peaches in relation to place of entrance

Liquid treatments were made by drenching fruit for 15 minutes

	Decay at stem-end	Decay other than stem-end	Total fruit decayed	Sound fruit	Total fruit examined
	(*percent*)	(*percent*)	(*percent*)	(*percent*)	(*number*)
1. Untreated checks	19.76	8.60	28.36	71.63	2,196
2. Dusting sulfur	8.50	3.45	11.95	88.04	1,882
3. Tap-water	18.26	6.08	24.34	75.65	345
4. Sodium hypochlorite at 120 p.p.m.	12.96	2.73	15.69	84.30	293
5. Sodium hypochlorite at 200 p.p.m.	12.09	5.00	17.09	82.90	579
6. Sodium hypochlorite at 320 p.p.m.	9.44	3.94	13.38	86.61	508
7. Sodium hypochlorite at 520 p.p.m.	8.90	2.45	11.39	88.60	921
8. Sodium hypochlorite at 750 p.p.m.	8.86	2.71	11.57	88.42	553
9. Sodium hypochlorite at 1,000 p.p.m.	6.79	1.80	8.59	91.40	884
10. Sodium hypochlorite at 1,530 p.p.m.	8.98	9.22	18.20	81.79	412
11. Sodium hypochlorite at 2,000 p.p.m.	20.40	13.04	33.44	66.55	299
12. DHA-S 0.10%	8.27	1.00	9.27	90.72	399
13. 8-Quinolinolin 0.02%	3.34	1.12	4.46	95.53	269
14. 8-Quinolinolin 0.03%	11.24	7.18	18.42	81.57	418
15. N.B. Vanillate 0.02%	17.31	5.85	23.16	76.83	410
16. N.B. Vanillate 0.03%	3.84	3.07	6.91	93.08	260
17. "Sta-Fresh"†	7.88	1.92	9.80	90.19	520
Total					11,148

*This lot was "Stericooled" for 30 minutes, by accident.
†"Sta-Fresh" is a brand name of a wax emulsion used to retard water loss. It is said to contain a fungicide, which appears to be quite effective. It was used at 1 part to 2 parts of cold water. It is also a product of Food Machinery and Chemical Corporation.

"Stericooling" without subsequent refrigeration reduced spoilage due to rot-causing organisms in the majority of dilutions of sodium hypochlorite.

No attempt is made to explain the discrepancies in results. Had only one set of untreated checks been used for all lapse-time treatments, as used for the first treatment in Table 1, most treatments would appear as good control. This was not the case, and separate checks were used for each period.

There was no evidence of injury to the fruit from any treatment that would have impaired its market value, other than from those that enhanced the entrance of organisms.

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WOOL CHARACTERISTICS, GROWTH, AND SKIN FOLDS IN A CROSS BETWEEN RAMBOUILLET AND BLACK TOP DELAINE SHEEP

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PROFESSOR GEORGE A. BROWN suggested, in 1929, an experimental cross between the American Rambouillet and the Improved Black Top Delaine Merino breeds.

The Rambouillet is a very popular breed in the United States because it combines desirable wool characteristics with mutton qualities unparalleled by any of the other Merino breeds. It exceeds the Delaine in body weight. But the Improved Black Top Delaines have smoother bodies and longer wool. In spite of the popularity of the Rambouillet as a fine-wooled sheep, its relatively short staple and light fleece are often criticized. The primary object of this experiment was to determine whether a cross between these two breeds could produce individuals that combined the better mutton qualities of the Rambouillet with the longer and heavier fleece of the Delaine. It was hoped that some advantageous heterosis might appear in the F_1 generation; though the descent of both breeds from Spanish Merinos indicated that they might be so much alike genetically that hybrid vigor would be absent.

Unavoidable limitations in barn space necessitated small numbers of sheep each year and the extension of the experiment over a number of years.

Two Rambouillet rams were crossed with 17 Improved Black Top Delaine ewes in 1929. Twenty F_1 generation animals were produced, of which 15 were raised (5 males and 10 females). Two of the F_1 males were crossed with 9 F_1 females. Forty-four F_2's were born. Of these, 37 animals (22 males and 15 females) provided most of the information for this generation. Data from Rambouillet and Delaine

[1]Mr. Ghanem made most of the mathematical calculations.

ARTICLE 35-7

animals, used as controls, were necessary to determine whether hybridization produced sheep superior to either breed. The controls were born during the years in which the F_2 generation was being produced.

Such an experiment cannot give information on the number of pairs of genes involved in the inheritance of each trait studied nor the mode of action of each gene, because: 1) there are no data on the Rambouillet and Delaine P_1 parents at one year of age, 2) the P_1 parents were probably not homozygous, and 3) the numbers of individuals secured were too small for such a study. The results are genetically suggestive, not conclusive. The chief objective of the experiment was to determine whether the Rambouillet $\times$ Delaine cross produced some superior sheep.

FIBER LENGTH

Davenport and Ritzman ('26) observed that long wool fibers appeared to be dominant to shorter fibers in a Rambouillet $\times$ Oxford cross. Hultz and Paschal ('30) reported that in the Rambouillet, fibers from the ram were longer than those of the ewe, and that fibers from shoulder and thigh samples were of approximately the same length. Terrill and Hazel ('43) calculated that differences in staple length for yearling range Rambouillet ewes were about 36 percent heritable. Hazel and Terrill ('45) found that the average estimate for heritability of staple length of range Rambouillet lambs at weaning was 0.40.

Two samples of wool were taken from each sheep shortly before shearing, at approximately 1 year of age, except that the P_1 parents were all at least 2 years old at the beginning of the experiment. A small pair of hair clippers was used. One sample was clipped from the middle of the shoulder, while the second sample was from the area directly posterior to the point of the hip. The cut was made as close to the skin as possible. Each of the two samples was labeled and placed in a tightly stoppered dry bottle. These samples were used for the investigation of fiber length, fiber diameter, and crimping.

The mean fiber length for a sample was estimated in the following manner. The sample was soaked in xylene (a fat solvent) until the grease was dissolved. After being dried at room temperature, 25 fibers were drawn at random from it with fine pointed forceps. Great care was exercised not to break a fiber. When breakage occurred, the fiber was discarded. The fiber was placed on a strip of dark velvet cloth beside a steel ruler, each end of the fiber was grasped with fine pointed forceps, then the fiber was gently stretched until the crimps dis-

appeared, after which its length in millimeters was read. The average length of the 25 fibers was corrected by linear interpolation to 365 days of growth.

Table 1 presents the mean fiber lengths and their standard errors for both shoulder and hip samples from the Rambouillet and Black Top Delaine controls and from the F_1 and the F_2 generations. All the differences between the four groups of sheep were significant by conventional statistical standards, except the difference between the Rambouillet and F_1 means. This was true for both shoulder and hip samples.

TABLE 1—Mean fiber lengths of the shoulder and hip samples, of the F_1 and F_2 generations, and of the control groups

(Corrected to 365 days of growth)

Group	Shoulder			Hip		
	Number of animals	Mean fiber length in mm.	Standard error of the mean	Number of animals	Mean fiber length in mm.	Standard error of the mean
Rambouillet controls	16	82.86	2.71	16	64.53	2.46
Black Top Delaine controls	18	103.54	1.79	18	83.42	2.75
F_1 generation	15	82.49	3.90	15	61.37	3.06
F_2 generation	37	92.65	1.62	37	74.17	1.76

For all four groups the mean length of shoulder fibers was significantly greater than the mean for fibers from the hip region.

The observations support the hypothesis that at least some of the genes for the shorter wool of the Rambouillet are dominant. In the sheep used, fibers from the shoulder were on the average significantly longer than fibers from the hip. The mean for the F_2 generation was very close to the average between the Rambouillets and Delaines. There was no evidence of a heterosis for fiber length that might make the Rambouillet × Delaine cross profitable.

Differences due to sex were not statistically significant.

FIBER DIAMETER

Davenport and Ritzman ('26) crossed Rambouillets with Southdowns, Hampshires and Oxfords. The F_1's from the Hampshire ×

Rambouillet matings grew wool with approximately the greater fiber diameter as that of the Hampshires. The Southdown × Rambouillet and the Oxford × Rambouillet crosses produced F_1's whose fiber diameters were intermediate between the parent breeds. Hultz and Paschal ('30) observed in Rambouillets that fibers from the shoulder had a smaller diameter than fibers from the thigh. Pohle and Schott ('43) reported concerning yearling Rambouillet ewes, "There appears to be a trend in average fineness from the smallest average diameter at the withers, shoulder, back, and side, to larger average diameters at the rump and belly, to the coarsest fibers at the thigh."

The mean diameter of the fibers of a sample from the sheep was determined from those sections of the fibers that emerged from the follicle during the month of January, approximately. Pasture conditions in spring, summer, and fall varied somewhat from one year to another, but it was assumed that management and feeding were very similar in mid-winter, year after year. About 10 small subsamples were drawn at random from the main sample after the latter had been soaked in xylene. The 10 subsamples were combined. The proximal section of the combined subsamples that grew after January was cut off with scissors. For example, assume that the sample had been removed from the sheep about March 15. Approximately the basal one-sixth of each fiber had come from the follicle since January 15. One-sixth of the total length of the combined subsample was cut with scissors from its proximal end and discarded. Two or three millimeters were then cut from the proximal end of the remaining subsamples and transferred to a drop of xylene on a slide, a cover glass was added, and the diameters of 50 fibers were measured with a calibrated filar ocular micrometer. Xylene did not cause the fibers to swell during measurement.

The quantitative data are given in Table 2. The mean fiber diameters for both shoulder and hip samples of the F_1's were larger than fiber diameters of the Rambouillet and Black Top Delaine controls. The differences are statistically significant. This might be interpreted as a case of heterosis, the Rambouillet and Delaines introducing into the F_1 generation different genes, which when within the same animal produce thicker fibers. Unfortunately, such hybrid vigor acts here in the wrong direction, inducing thicker fibers when thinner ones are wanted. The phenomenon might be called "negative" heterosis.

The shoulder and hip samples of both Rambouillets and Delaines did not differ significantly, though the hip samples were slightly

TABLE 2—Mean fiber diameters of the shoulder and hip samples of the F_1 and F_2 generations, and of the control groups

(Measurements made on segments of fibers grown during January, approximately.)

Group	Shoulder			Hip		
	Number of animals	Mean fiber diameter in microns	Standard error of the mean	Number of animals	Mean fiber diameter in microns	Standard error of the mean
Rambouillet controls	16	18.11	0.75	16	19.24	0.90
Black Top Delaine controls	18	17.57	0.76	18	18.95	0.75
F_1 generation	15	20.61	0.41	15	21.80	0.35
F_2 generation	37	18.86	0.48	37	20.48	0.57

courser. The t values indicated that the hip fibers of F_1 and F_2 sheep were significantly thicker than those from the shoulder.

The coefficients of variation for shoulder samples in the crossbreds were: for F_1's, 0.077; for F_2's, 0.154. The coefficients of variation for the hip samples were: for F_1's, 0.062; for F_2's, 0.169.

Differences between the sexes were not statistically significant.

CRIMPS

Davenport and Ritzman ('26) observed in the F_1's that the average crimping was intermediate between that of the P_1 parents, with evidence of imperfect dominance of crimpiness.

Hultz and Paschal ('30), studying Rambouillets, found that the finer fibers were the more crimped, and that shoulder samples had more crimps per inch than thigh samples.

The degree of crimpiness of the wool examined in the current study was the number of crimps in 2 centimeters of staple length. Crimping was measured in the intact wool sample before it was treated with xylene. A surface was located where the crimping showed most plainly and the number of crimps in 2 centimeters was counted. This was done in four places on the sample. The four counts were averaged to secure the rating. Care was exercised not to stretch the wool while the crimps were being counted.

Table 3 presents the data on crimping. The majority of the differences between means were not statistically significant. The Rambouillet and Delaine controls showed substantially the same degree of crimpiness. The shoulder fibers of the F_1 generation had significantly fewer crimps than the corresponding fibers of the Rambouillets. A similar relation possibly existed between the Delaines and the F_1's. Hip samples showed no significant differences between means. The decline in crimps in the F_1 generation accompanied the coarsening of fibers shown in Table 2.

TABLE 3—Mean number of crimps per 2 centimeters of fiber

Group	Shoulder			Hip		
	Number of animals	Mean number of crimps per 2 cm.	Standard error of the mean	Number of animals	Mean number of crimps per 2 cm.	Standard error of the mean
Rambouillet controls	16	15.0	0.35	13	13.0	0.43
Black Top Delaine controls	18	14.7	0.43	18	12.6	0.62
F_1 generation	15	13.6	0.33	5	12.1	0.64
F_2 generation	37	14.1	0.30	35	12.4	0.38

In all four classes of sheep shown in Table 3, there was more crimping in the shoulder fibers than in those from the hip. The differences were statistically significant for the Rambouillets, Black Top Delaines, and the F_2 generation.

UNSCOURED FLEECE WEIGHT

Davenport and Ritzman ('26) crossed Rambouillets with Southdowns and Oxfords. The mean raw fleece weights of the F_1's approximated the lighter fleece weights of Southdowns and Oxfords. Study of the scoured wool showed no decided indication of dominance in the F_1 generation. Terrill and Hazel ('43) estimated that the coefficient of heritability for clean fleece weight in yearling range Rambouillet ewes was 38 percent, and for grease fleece weight 28 percent.

Table 4 gives the means for unscoured yearling fleece weights of the Rambouillet and Delaine controls, and for the F_1 and F_2 genera-

tions. The data for males and females are given separately. The authors had no facilities for scouring the fleeces. Of course, the animals were not sheared at exactly one year of age, so all fleece weights are corrected to 365 days of growth.

TABLE 4—Mean unscoured yearling fleece weights, corrected to 365 days of growth

Group	Males			Females		
	Number	Mean fleece weight in pounds	Standard error of the mean	Number	Mean fleece weight in pounds	Standard error of the mean
Rambouillet controls	3	7.58	1.28	12	8.76	0.42
Black Top Delaine controls	7	12.95	1.21	11	9.78	0.69
F_1's	5	15.49	0.80	10	12.96	0.60
F_2's	22	12.71	0.70	15	9.48	0.46

The number of individuals was small. Nevertheless, the results are suggestive. The F_1 males yielded twice as much wool as the Rambouillet males, and the difference between them was statistically significant. The yield of F_1 males was larger than the yield of Delaine males, but the excess was not significant. F_2 males regressed to approximately the Delaine level, but were still significantly above the Rambouillet in yield. The mean yield of the F_1 females significantly exceeded the means for both Rambouillet and Delaine females. The F_2 females were intermediate between Rambouillets and Delaines. The declines from F_1 to F_2 males, and from F_1 to F_2 females were both statistically significant.

The coefficients of variation were: F_1 males, 0.116; F_2 males, 0.257; F_1 females, 0.147; and F_2 females, 0.187. The increased variation in F_2 over the F_1 generation is what one would expect as a consequence of the recombinations of genes characteristic of an F_2 generation.

The foregoing results very strongly suggest that the Rambouillet $\times$ Black Top Delaine cross could be used to produce F_1 crossbreds that would yield more unscoured fleece than either parent breed. This seems to be a case of heterosis, or hybrid vigor, for there was a significant decline in yield from the F_1 to the F_2 generation. The number of

individuals observed in this experiment was so small that, regardless of t values, one should refrain from drawing conclusions. Also, there may be an increase in the grease content of the wool and not more scoured wool, which is the important consideration. The authors merely suggest that the results would justify the repetition of the experiment, using many more sheep, and determining weights of scoured wool to discover whether hybrid vigor is actually present.

The Black Top Delaine, F_1, and F_2 males grew significantly more wool than the females of the same groups.

SKIN FOLDS

Jones, Warwick, Dameron, Davis, McPhee, and Spencer ('36, '37, '38, '39, '40) crossed Rambouillet rams with Corriedale ewes. They suggested that there is some dominance of the genes for freedom from skin folds. Madsen, Esplin, and Phillips ('43) found evidence that skin folds are influenced by heredity, but not strongly. Terrill and Hazel ('43) calculated that the estimates of heritability for neck folds and body folds were 26 and 32 percent, respectively, in yearling range Rambouillet ewes. Jones, Warwick, Phillips, Spencer, Godbey, Patterson, and Dameron ('46) suggested that lack of skin folds is due to dominant multiple genes. Terrill and Hazel ('46) found the average estimate of heritability for neck folds was 0.39 in range Rambouillet lambs.

Photographs, in side view, were taken of the F_1's, F_2's, and the Rambouillet and Delaine controls when they were about 1 year old, shortly after shearing. Yearling pictures of the P_1 parents were not available.

These photographs were used to calculate a skin fold index for each sheep. Every wrinkle on the neck and trunk was given a value, which was a fraction whose numerator was the length of the fold as shown on the photograph and whose denominator was the dorso-ventral dimension, on the photograph, of the neck or trunk at the level of the fold. Those fold values representing the folds in the neck region as far back as the shoulder were added together, and the sum was called the "neck value." The fold values from the shoulder to the thigh were added, and the sum of these fractions was called the "body value." The folds on the rump, the tail-head and the thigh ran in diverse directions, so could not be evaluated with reference to the

width of the parts showing the folds. The "neck value" and the "body value" were combined to form the fold index for that sheep.

The means for the neck and body skin fold values were:

	Neck fold values	Body fold values
Rambouillet	5.61	4.30
Delaine	4.82	5.92
F_1	5.93	7.81
F_2	5.44	5.13

Ghanem ('51), subjecting these data to the analysis of variance, found that the mean square for sex was not significant.

The neck fold values and the body fold values are combined in Table 5. Since no significant sex differences were found, the sexes

TABLE 5—Mean skin fold indices at yearling age

Group	Number of sheep	Mean skin fold index	Standard error of the mean
Rambouillet controls	10	9.92	1.08
Black Top Delaine controls	12	10.74	1.40
F_1 generation	14	13.74	0.69
F_2 generation	32	10.57	0.58

were not differentiated in this Table. The mean skin fold index for the F_1 generation exceeded the index for the Rambouillet controls by an amount which is significant at the 1-percent level. The F_1 index likewise exceeded that of the Delaines, but the difference was not significant at the 5-percent level, though Ghanem ('51), by using the method of weighted mean differences, found the difference between the Delaines and F_1's significant at the 5-percent level. The mean of the F_2 generation was between the means for Rambouillets and Delaines but closer to the Delaines. The coefficient of variation of the F_1's was 0.189, and of the F_2's it was 0.312. This increase certainly suggests recombinations of genes for skin folding.

Thus there was some evidence of hybrid vigor with respect to skin folding when Rambouillets and Delaines were crossed, for the index of the F_1 exceeded the index for either parent type. But skin folding is coming to be regarded as an undesirable character, so such heterosis does not commend this cross to sheep breeders.

BODY WEIGHT AND GROWTH

Ritzman ('17) found that lambs accomplished about 60 percent of their gain in weight during the first 3 months, 20 percent during the second 3 months, 15 percent during the third 3 months, and 5 percent during the last 3 months. Ritzman ('23) observed no heterosis for body weight in a cross of Southdown × Rambouillet. Terrill and Hazel ('43) found that in yearling range Rambouillet ewes, heritability was 40 percent for body weight. Hazel and Terrill ('45) calculated that the average estimate of heritability for weaning weight was 0.30 in range Rambouillet lambs.

The weights, in pounds, of the F_1, the F_2, and the control sheep were obtained at 2-week intervals until 16 weeks of age, then at 4-week intervals up to 1 year of age or later. The weights could not conveniently be obtained, as a rule, at exactly 6, 8, 10, etc. weeks of age. Therefore, the recorded weights of each animal were corrected by linear interpolation to secure estimated weights for all the sheep at 6, 8, 10, 12, 14, 16, 20, 24, 28, 32, 36, 40, 44, 48, and 52 weeks of age.

To determine whether there is any evidence of hybrid vigor, the body weights at 6, 16, and 52 weeks are assembled in Table 6. In preparing this table all weights were corrected to a single-birth female basis by means of conversion factors for sex and type of birth (single or multiple). The conversion factor for sex to be used at 6 weeks of age was calculated thus. The average 6 weeks' body weight of all the female single sheep was divided by that of all the male singles ($29.54/34.23 = 0.863$). Then the average 6 weeks' body weight of all the female twins was divided by that of the male twins ($24.00/26.83 = 0.894$). The average of these two values, 0.878, was the conversion factor for sex at 6 weeks of age. The weight of a single male 6 weeks old was converted to the single female basis by multiplying its weight by 0.878.

The conversion factor for type of birth was calculated in a similar manner. The average body weight at six weeks of age of all the single females was divided by that of all the twin females ($29.54/24.00 = 1.231$). Then the average 6 weeks' body weight of all the single males was divided by that of the twin males ($34.23/26.83 = 1.276$). The average of these two values, 1.254, was the conversion factor for type of birth at the age of 6 weeks.

All the weights as of 6 weeks were then reduced to the single female basis.

TABLE 6—Body weight and growth

(All weights are adjusted to a female, single-birth basis)

Group	6 weeks		16 weeks		52 weeks		
	Number of sheep	Mean weight in pounds	Number of sheep	Mean weight in pounds	Number of sheep	Mean weight in pounds	Standard error of mean
Rambouillet controls	24	30.62	25	57.09	23	94.09	4.40
Black Top Delaine controls	22	27.85	22	49.31	19	88.44	5.30
F_1's	14	30.54	15	55.43	15	112.73	2.52
F_2's	38	29.97	38	53.55	38	88.36	3.53

The same procedure was followed in correcting body weights at 16 and 52 weeks of age. The conversion factors for these ages were:

1) at 16 weeks, for sex, 0.832; for type of birth, 1.100.
2) at 52 weeks, for sex, 0.812; for type of birth, 1.114.

Figure 1 shows the growth curves of single-birth females of the two types of controls and of the F_1 and F_2 generations. The curves show the growth of 10 Rambouillet females, 9 Delaines, 10 F_1's and

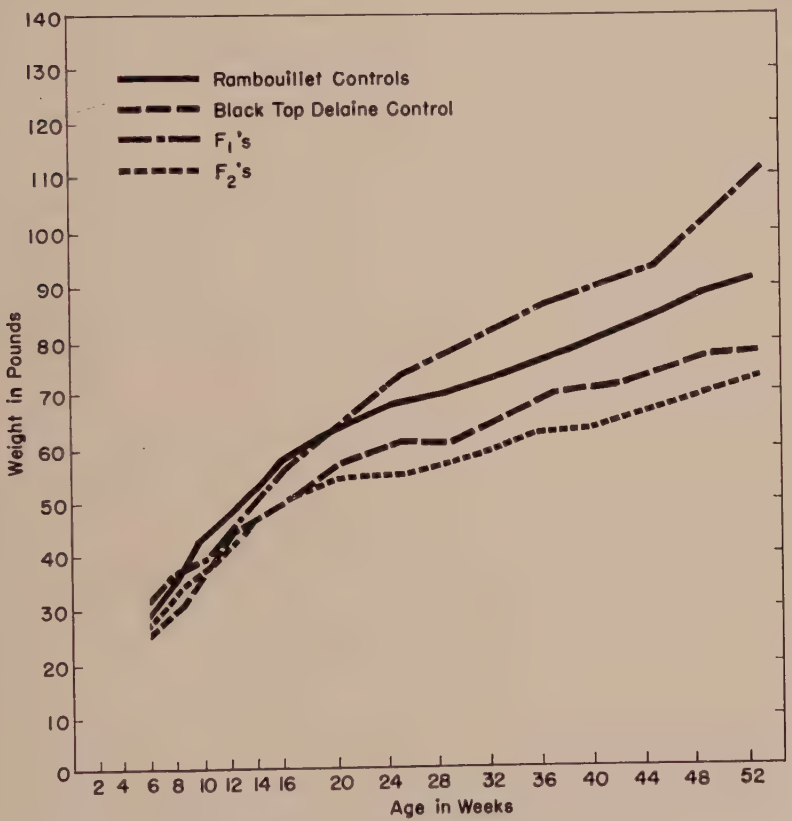

Fig. 1. Growth curves of single-birth females.

7 F_2 females. There were too few single-birth males to justify constructing growth curves: 4 F_1's, 2 Rambouillets, and 3 Delaines. Figure 1 shows that at 16 weeks of age Rambouillet single-birth control females weigh most, followed closely by the F_1 single-birth females. Shortly thereafter the F_1 curve for females crosses the Rambouillet control curve, and by 52 weeks the F_1's exceed the Rambouillets by

about 20 pounds. The weights of the single-birth Black Top Delaines and of the F_2's are consistently less than either Rambouillets or F_1's.

Table 6 gives the body weights at 6, 16, and 52 weeks, with the weights of males and members of twin pairs corrected to a female single-birth basis, as just described. At 6 and 16 weeks the weights of both F_1's and F_2's are between the weights of the two control groups, though the F_1's approach the weights of the heavier Rambouillets, and the F_2's are somewhat lighter in weight than F_1's.

The main practical interest is in the yearling weights. Is there evidence of hybrid vigor? The F_1's at 52 weeks exceed the Rambouillet controls by 18.6 pounds, and the Delaine controls by 24.3 pounds (Table 6) and both of these differences are statistically significant. The mean weights of single-birth females at 52 weeks (Fig. 1), and the adjusted weights at 52 weeks can be reasonably interpreted as hybrid vigor which is not manifested until the animals are more than 20 weeks old. If it should appear desirable from a practical point of view to produce heavier-bodied fine-wooled individuals, the Rambouillet × Delaine cross should be repeated, and larger numbers should be bred to determine whether our interpretation of these observations is correct.

CORRELATIONS BETWEEN TRAITS

Table 7 gives coefficients of correlation between skin fold indices, wool characteristics and body weight at 52 weeks when these correla-

TABLE 7

Traits correlated	10 Rambouillet controls	12 Delaine controls	14 F_1's	32 F_2's
Skin fold index and				
unscoured fleece weight	.....	.....	.....	+0.358*
fiber length	.....	.....	−0.753**	.....
Unscoured fleece weight and				
body weight	+0.953**	+0.748**	+0.664**	+0.808**
fiber diameter	+0.958**	+0.614*	.....	+0.476**
Fiber diameter and				
body weight	+0.901**	.....	.....	+0.576**
fiber length	.....	+0.596*	.....	.....
Crimp	.....	−0.578*	.....	−0.534**

*Significant at 5-percent level.
**Significant at 1-percent level.

tion coefficients are statistically significant. Other correlation coefficients have been calculated, but none of them is significantly different from zero.

JUDGE'S RATING OF THE SHEEP

Professor George A. Brown of the Department of Animal Husbandry examined most of the F_1 and F_2 sheep, and gave the following judgments. There was one very desirable ram among four F_1 rams examined. There were five very desirable ewes among nine F_1 ewes. Among 22 F_2 rams, only one was regarded as very desirable, and there was only one superior ewe among 15 F_2 females. These judgments support the view that on the average the F_1's were better animals than the F_2's, which again suggests a desirable type of hybrid vigor in the F_1's.

CONCLUSIONS

If one uses conventional genetic methods to determine the mode of inheritance of economically important traits in livestock, the types crossed at the beginning of the experiment should be homozygous, or nearly so, and large numbers of descendents should be raised. But such homozygous strains probably almost never exist in livestock, and it is very costly to raise adequate numbers of the larger farm animals. Economically important traits are usually sensitive to environmental influences, and it is expensive to standardize the environment of large numbers of such animals as sheep, hogs, and cattle. If one proposes to use gene frequency analyses of matings or pedigrees, there is a lack of accurate records of the traits being studied, and where there are such records there has often not been painstaking control of environmental influences.

All these difficulties were recognized at the outset, but the experiment seemed worth while even though barn space was inadequate and it was recognized that only a small number of animals could be observed each year.

It was hoped that the F_2 generation would yield a few individuals that combined the better mutton qualities of the Rambouillet with the longer wool and smoother bodies of the Black Top Delaine. Such individuals were not secured. If more F_2's could have been produced, they might have appeared. Further effort might well prove to be worth-while.

On the other hand, there is evidence of hybrid vigor, heterosis, in the F_1 generation. These F_1's, when one year old, were significantly heavier than the Rambouillet and Delaine controls, and they grew more unscoured wool. To offset this, there was a "negative heterosis" in the F_1's, in that they were more wrinkled and the wool fibers were coarser than in Rambouillets and Delaines.

Several additional points are worth emphasizing:

1) At least some genes for short wool seem to be dominant.

2) Wool samples from the shoulder region have, on the average, longer fibers, smaller fiber diameters, and more crimping than those taken from the hip region of the same animals.

3) There are consistent and significant positive correlations between unscoured fleece weight and body weight, and between unscoured fleece weight and fiber diameter.

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EFFECTS OF STILBESTROL-PROGESTERONE IMPLANTS ON THE GROWTH AND CARCASS QUALITY OF LAMBS[1]

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WITH THE INCREASING PRICES being paid for farm livestock and meat products, considerable attention is being given to the use of growth-stimulating hormones and drugs to increase the rate of gain, improve the efficiency of feeding, and produce higher quality carcasses. Andrews and Bohren (1947) found that stilbestrol improved the carcass quality and increased the efficiency of gain in chickens. Dinusson *et al* (1949) found that stilbestrol increased rate of gain, feed consumption, growth rate, and feed efficiency of heifers. Andrews (1949) reported that implanting 12 mg. of stilbestrol did not increase the gain in suckling lambs; however, Jordan (1950) found that 12 mg. implantation in 4-month-old and 8-month-old lambs increased the rate of gain and reduced the amount of feed per hundred pounds of gain. O'Mary *et al,* (1951) noted that lambs implanted with stilbestrol made more rapid gains, required less feed per pound of gain, but had less finish, lower carcass grade, and lower dressing percentage than the controls. He also reported that progesterone implantation produced no effect.

Data reported by Meites, Reineke and Cairy (1952) and Reineke, Meites, Cairy and Huffman (1952) have indicated that implantation of combinations of stilbestrol and progesterone increased body weight and finish in heifers and cows. Gains in body weight of 200 to 300 pounds were observed during implantation periods of 3 months. This may explain the higher degree of finish which Snapp and Bull (1944) found in pregnant as compared with open heifers, since estrogens and progesterone are secreted in large quantities during pregnancy. It seemed possible, therefore, that a

[1]The work reported herein is part of a Master of Science thesis to be submitted by the senior author to the Graduate School of Michigan State College.

ARTICLE 35-8

combination of an estrogen and progesterone would be more physiological than estrogen alone for inducing optimal body growth and finish. The work reported here represents a preliminary attempt to test this hypothesis in lambs.

MATERIALS AND METHODS

Twenty spring lambs, averaging about 5 months old, were taken from the College flock and placed in feedlots. They consisted of 11 Shropshires, 7 Columbia X Shropshires, and 2 Suffolk X Shropshires. The lambs were divided into two groups as equally as possible as to weight, sex, type and breeding. Group I received no implantations and constituted the control lot. The lambs in Group II received a 25 mg. pellet of diethylstilbestrol and a 250 mg. pellet of progesterone, inserted subcutaneously in the neck at the beginning of the experiment.

The trial began on September 2, 1951. The control group was slaughtered on December 19, 1951, and the treated group on December 20, 1951. Each lamb was weighed individually at the start of the experiment and every 7 days until the end of the experiment. Both groups were fed a ration of cracked corn and alfalfa hay and had free access to phenothiazine salt mixture and fresh water. Each group was started at the rate of 0.1 pound of corn per lamb, the amount being increased daily until the lambs were on full feed. Both groups were fed hay in the same feeders with the corn. The corn was fed twice a day and limited to the amount eaten in a reasonable period of time. The net amount of feed consumed was the total amount fed less the unconsumed portions.

Both groups were unshorn and had access to outside exercising lots as well as to sheltered feeding area. One control lamb died of toxic enteritis during the fourth week. In the sixth week a treated lamb died of pneumonia. In the eighth week another treated lamb died of parasitic infestation and pneumonia. A control lamb was removed for unthriftiness; the results herein reported are on the basis of eight lambs per group.

Before slaughtering, all lambs were graded by experienced judges. Slaughtering was done in the standard way, hot dressed weight recorded, and then the carcasses were chilled for 48 hours at 34° F. The chilled carcasses were weighed and graded in accordance with U.S. Department of Agriculture standards, and dressing percentages were computed. In cutting the carcasses the method described in

U.S.D.A. Technical Bulletin 944 was followed, and a nine-rib rack was removed from each carcass, wrapped and frozen for future physical separation. A sample of external fat from each lamb was analyzed for moisture content. As time permitted, the racks were removed from the freezer, the percentage of freezer loss computed, and the physical separation into fat, lean and bone and ligament completed. From the percentages of fat, lean and bone and ligament of each nine-rib rack, the composition of each carcass was determined by using the estimating equations given in Bulletin 944.

RESULTS AND DISCUSSION

The effects of stilbestrol and progesterone implanted together on the rate of growth and carcass quality are summarized in Table 1 and Fig. 1. Each control lamb gained 0.31 pound daily for 89 days. The treated lambs each gained 0.42 pound daily for 90 days and averaged

TABLE 1—Effects of stilbestrol and progesterone on growth rate, feed consumption and efficiency, and carcass grade and dressing percentage of lambs

	Control	Treated
Number of lambs*	8	8
Average starting weight (lb.)	66	65
Average final weight (lb.)	94	103
Gain/lamb, (lb.)	28	38
Average daily gain/lamb (lb.)	0.31	0.42†
Average Daily Feed Consumption (lb.)		
Cracked corn	1.05	1.18
Alfalfa hay	1.96	2.12
Total	3.01	3.30
Feed per 100 Pounds of Gain (lb.)		
Cracked corn	332	254
Alfalfa hay	623	502
Number of Carcasses in Each Grade		
High prime	0	2
Average prime	3	4
Low prime	3	2
High choice	1	0
Average choice	1	0
Dressing percent	48.2	49.3

*Two lambs from each lot died or were removed for general unthriftiness, and feed figures were corrected for smaller lots.

†Computed on basis of total average gain per day.

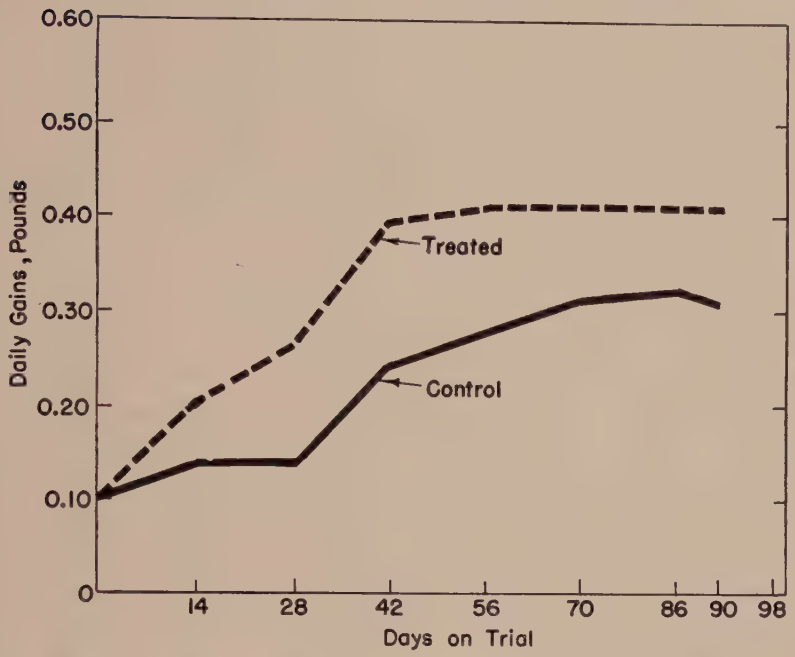

Fig. 1. Graph showing differences in daily body weight gains made by control and hormone-treated lambs.

10 pounds heavier. They also consumed more feed and showed greater feed efficiency than did the controls. Although not noted herein, analysis of the data indicates that treated wether lambs had a higher dressing percentage than ewe lambs; the converse was true for the control lambs.

It was noted that the treated lambs were more easily kept on feed. The lambs were unshorn, and periods of unseasonal hot weather caused the control lambs to go off feed twice during the experiment. The control lambs gambolled about in true lamb-like fashion at feeding time, while the treated lambs were more placid but not sluggish and seemed interested only in eating at feeding time. At the 70th day, all the treated ewe lambs showed some mammary development, particularly in the teats, and the heavier lambs showed slight secretion. The wether lambs were negative for mammary development.

The control lambs were slaughtered on the 89th day, the hot carcesses were weighed, then chilled, and the cold dressing percentage computed. On the 90th day the treated lambs were slaughtered, and the same procedure was followed. There were no pellets recovered from the treated lambs as apparently all the material had been ab-

sorbed. The average dressing percentage for the control lambs was 48.2, and for the treated lot it was 49.3 percent.

A nine-rib rack was removed from each carcass and placed in a freezer. The original weight was compared with the weight when the rack was removed for physical separation, and the freezer loss computed. The average freezer loss for the control group was 1.17 percent and 1.15 percent for the treated group.

Samples of external fat were removed from each rack 2 weeks after freezing and analyzed for moisture content by the following method: The samples were brought to a constant weight in a full vacuum at 75° C. Two trials were run. In the first trial the fat samples were kept at 75° C. in full vacuum by a Cenco High Vacuum pump for 23½ hours. Moisture was determined by difference. The samples were reheated at the same rate under full vacuum for an additional 23½ hours. For the second trial the same method was used except that the time was 41 hours without the reheating. The moisture content of the fat of the control group was 5.49 percent, while that of the treated group was 5.40 percent. Typical and similar cuts from the control and treated groups are shown in Fig. 2. As indicated in Table 2, the nine-rib racks of the control group had more bone and ligament.

Fig. 2. Nine-rib racks were taken from the control and treated lambs at the time of slaughter. Left rack is from a lamb in the control group, and the right from one in the treated group. Note the thicker external fat and greater marbling of the right rack, which was typical of those of the treated lambs. When slaughtered the control lamb (left rack) weighed 94 pounds and dressed out 46.7 percent, while the treated lamb (right rack) weighed 100 pounds and dressed out 49.5 percent. Both weighed 70 pounds at the start of the experiment.

*TABLE 2—Physical carcass composition**

	9-Rib rack						Carcass					
	Bone		Lean		Fat		Bone		Lean		Fat	
	Percent	Range	Percent	Range	Percent	Range	Percent	Range	Percent	Range	Percent	Range
Control....	17.44	14.90 25.28	45.12	37.71 53.23	36.82	24.08 46.69	17.58	15.58 23.68	50.71	45.96 55.13	30.79	21.86 35.87
Treated ...	16.63	15.55 17.58	41.39	36.89 44.24	41.39	38.14 45.09	16.93	16.09 17.67	48.36	45.41 50.24	33.98	31.70 36.56

*As determined from following estimating equations:

Bone and ligament $Y = 3.96+0.78X$

Lean $Y = 21.22+0.656X$

Fat $Y = 5.00+0.70X$

more lean, and less fat than the treated group but the range was wider in each case. Based on the percentages of the nine-rib rack, the composition of the whole carcass showed the same interrelationships.

Previous work on lambs, as reported by O'Mary *et al*, (1951), showed that stilbestrol alone produced a heavier carcass but was of lower quality. The results noted here indicate that combinations of stilbestrol and progesterone produced carcasses of higher quality with greater efficiency of gain than untreated lambs.

SUMMARY

The implantation of a 25 mg. pellet of stilbestrol and a 250 mg. pellet of progesterone subcutaneously in the neck of 5-month-old feeder lambs increased the rate of gain 0.11 pound daily over control lambs. The hormones decreased the feed required per hundred pounds of gain by about 20 percent. Lambs treated with stilbestrol and progesterone had a higher dressing percentage and produced higher grading carcasses. The treated lambs averaged 10 pounds heavier than the controls at the end of the 89-day experimental period.

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MECHANICAL STONEPICKERS[1]

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STONES ON AGRICULTURAL LAND have been a nuisance as long as man has tilled the soil, but in the mechanized agriculture of today their removal from the soil is perhaps more important than ever before. They affect the use of mechanical farm equipment by 1) causing breakage and lost time, 2) causing more rapid wear, and 3) making it necessary to operate equipment at reduced speed. Modern farm equipment can be used most efficiently on land where there are no stones with a diameter larger than about 2 inches. A forage harvester or combine may be extensively damaged by a single stone no larger than a baseball.

METHODS OF REMOVING STONES

The removal of large stones or boulders requires special methods and equipment. A common method where large stones are few in number is to bury them by digging a hole along side and partly underneath until it is easy to roll the boulder in the deeper hole, thus lowering it sufficiently to prevent interference with tillage implements. This has often been done by hand digging, but bulldozers and power shovels have speeded the work and made it safer. Stoneboats have long been used for removing stones small enough to be handled in this manner, and bulldozers are used for pushing boulders off the field if the distance is relatively small. Another much-used method has been to hitch directly to the stone with rope or chain and drag it off the field.

Explosives have been useful and extensively employed for breaking large boulders into smaller pieces which could be handled and trans-

[1]Condensed from a thesis by the junior author, entitled "Mechanical Removal of Stones from Agricultural Land", for the degree of Master of Science, Michigan State College, 1951.

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ARTICLE 35-9

ported. The fast dynamites with at least 50 percent nitroglycerine have generally been recommended.

Blasingame, Keesler, and Josephson (1930) reported that the cost of clearing limestone rock from a field on the Pennsylvania State College Farm was reduced 25 to 50 percent when a combination of methods was used, including a subsoil implement for hooking the stones loose, and dynamite for "mud-capping" and "snake-holing". The use of dynamite alone resulted in higher costs.

In Sweden, the Agricultural Machinery Testing Institute has reported on methods and equipment used there for removing large boulders. A hole is drilled in the stone, either with a motorized or compressed air drill, and a pin with an eye is wedged in the hole. This pin serves as a point of attachment for lifting the boulder on a transporting wagon, some of which are equipped with a lifting device. Boulders weighing up to seven tons have been handled in this way.

Nearly 100 years have passed since the first patent on a stone gatherer was granted in the United States, but only in recent years have machines been produced for picking stones from the land. These machines are designed to handle stones ranging in size from about 2 to 10 inches, and so far as is known are built by only four manufacturers.

TYPES OF MACHINES

Stone-gathering machines follow several designs. Early attempts resembled reconstructed shaker-type potato diggers, but were not readily accepted owing to the narrow width of ground covered and the tendency for stones to wedge in the apron.

One manufacturer (Fig. 1) uses a 3-foot wide raking bar under a two-wheel trailer gear which collects the stones in front of the rake. A revolving cylinder driven from the tractor power take-off throws the stones into a hopper which dumps them into a carrier box of one ton capacity. A tractor of 20 or more drawbar horsepower is required for pulling the machine. Unloading can be accomplished by dumping the stones from either side, either while the machine is standing still or in motion. The height of the picking mechanism is hydraulically controlled.

Another make which uses a two-wheel trailer vehicle has a 3-foot wide picking mechanism mounted on the rear axle and uses a small gasoline engine for power to drive the mechanism (Fig. 2). The size of tractor required for pulling the machine is 15 or more drawbar

Fig. 1. An early model of trailer-type stonepicker. Later machines are mounted on two wheels.

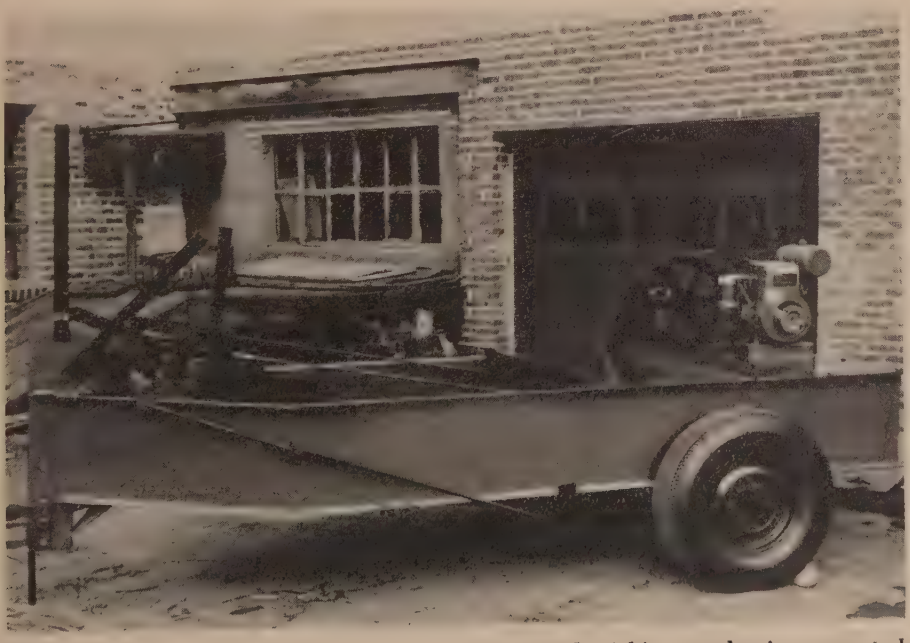

Fig. 2. Two-wheel trailer-type stone picker with picking mechanism operated by auxiliary engine.

horsepower. The stones are picked up onto a bed where they are delivered to the trailer box of one ton capacity.

An interesting machine (Fig. 3), which has been in use about 5 years, covers a width of 8 feet and employs a tined gathering scoop which can be raised by two double-acting hydraulic cylinders to dump the gathered load off the back of the scoop into a solid bucket or hopper. Another pair of hydraulic cylinders raises the hopper for dumping the collected stones. A tractor of 20 or more drawbar horsepower is necessary for operating the machine.

A machine which a manufacturer has had under development and test during the past 2 or 3 years uses a potato digger heavy-duty type apron which is slightly over two feet wide (Fig. 4). Stones are delivered into a breaker chamber where they are pulverized and returned to the soil. The picking mechanism is operated by tractor power take-off drive and the stone crusher by auxiliary engine and multiple V-belt drive. The machine is mounted on two large rubber tired wheels on the rear and two smaller castering wheels on the front. This machine weighs about 5,000 pounds, but since it does not accumulate a load of stones its gross load is not in excess of some of the other machines

Fig. 3. Hydraulically-operated tined stone-gathering scoop dumps stones into rear hopper.

when they are carrying a load. A tractor of 30 or more drawbar horsepower is required for pulling the machine.

Fig. 4. Stone picker which pulverizes the stones and returns the material to the soil.

FIELD TESTS

Field trials were made using a machine developed by a manufacturer during the past 6 years (Fig. 5). Revolving windrowers gather the surface stones into a windrow, and elevator buckets pick up and dump the stones into a two-wheel trailer attached at the rear. The dump-type trailer is easily detached and hauled away by the tractor hitch on the rear.

The windrowing and elevating mechanisms are both ground driven and under some conditions slippage resulted. To eliminate that possibility the windrower should be converted to power take-off drive. The windrower covers a maximum width of 9 feet, which can be decreased to reduce the power requirements.

Draft tests indicated a maximum pull of about 3,270 pounds, and unless grades are moderate and soil conditions good, a track-type tractor should be used. To pull the machine, 30 or more drawbar horsepower is necessary. A wheel-type tractor is satisfactory for hauling the trailer.

Stones should be brought to the soil surface by a spring-tooth harrow or other satisfactory methods. The soil must be pulverized enough so that any clods are smaller than the stones being gathered; otherwise, too much soil will be removed with the stones. Also, the soil must not be too wet or it will clog the machine or be removed with the stones.

Fig. 5. Windrowing-type stone picker with attached trailer.

Under good field conditions and without undue machine trouble, two tons of stones can be harvested and hauled away in 15 minutes. In some places tested surface stones were present in the quantity of 51 tons per acre. The sizes of stones picked ranged from 2 to 9 inches. Stones larger than 9 inches must be removed by other means.

STONE PICKING COSTS

The cost per hour of picking stones by machine is the sum of the costs for 1) depreciation, 2) interest, housing, taxes and insurance, 3) repairs, 4) power and 5) labor. Assuming a machine life is 1,500 hours and 200 hours of use per year, the hourly costs of use per $100 of new machine cost are as follows:

1. Depreciation @ $0.066	$0.066
2. Interest, Housing, Taxes and Insurance at 7% of one-half new cost	.018
3. Repairs, total 60% of new cost, @ $0.040	.040
Total	$0.124

If a machine costs $2,000 the cost per hour is $2.48

4. Power, tractor cost of use, less operator per hour	1.25
5. Labor, estimated @ $1.00 per hour	1.00
Total estimated cost per hour	$4.73

The cost per acre will vary over a wide range, owing to the many conditions encountered. Normally it will require from 2 to 4 hours per acre to gather the stones, not including the plowing and spring-tooth harrowing. Thus, cost of stone harvesting with a picker could range from a low of about $5 per acre to a high of $25 or more.

Cost of stone picking is reduced by the use of a second trailer, tractor and operator to permit unloading one trailer while the machine continues to fill the other. When the hauling distance is long (one-fourth mile or more) the time per acre would be decreased about one-half and the cost per acre reduced about one-fourth.

Comparative field tests of machine picking and picking with fork-scoops indicated two men would require about 6 to 8 hours to pick the same quantity of stones by hand as were picked by the machine on one acre. Computing costs on the same basis as before, but not including a tractor driver, the cost per acre would be about $20 per acre for hand picking compared with about $10 for machine picking.

PRACTICABILITY OF MECHANICAL STONE PICKING

Stone pickers are relatively new machines and will be improved by further developmental work. As mentioned previously, four manufacturers are currently producing stone pickers, and several features seem to have considerable merit.

The capacity and cost of most of the machines are greater than many individual farms could economically support. Thus, the owner of a stone picker should solicit custom work if his own acreage is not extensive enough to warrant ownership of a machine. Another factor

to consider is the size and type of tractor needed to pull the stone picker successfully. Most of the machines are heavy draft, and only the larger wheel tractors can pull them. Track-type tractors are more satisfactory in most situations.

The Michigan tests show the cost per acre of picking stones to be about 25 percent less than hand picking when one trailer was used with the picker, and about 40 to 50 percent less when a second trailer was used. However, stone picking by hand is a laborious job and is usually avoided, thus leaving the stone removal job undone. Successful stone pickers are of considerable interest to farmers, and light-draft machines for use with two- to three-plow size farm tractors will aid in much needed land improvement.

Stone picking is a job that is not normally completed in a once-over operation. Even though many stones are brought to the surface of the plow furrow slice by spring-tooth harrowing, there are also many stones remaining in the soil which are surfaced in subsequent seasons of tillage. Variations in tillage depths, frost action, and soil erosion effects continue to yield stones into the cultivated surface of the soil. Thus, the operation may need to be repeated periodically to free the soil of bothersome stones.

A RECIRCULATING DRIER FOR DRYING PEA BEANS WITH HEATED AIR

(A Preliminary Report)

By CARL W. HALL and ROBERT L. MADDEX
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MICHIGAN IS ONE OF THE LEADING STATES in the production of edible dry beans. In 1951, Michigan farmers produced 3,755,000 bags of cleaned pea beans, which amounted to 92 percent of the United States production. In addition, they produced practically all of the dark red kidney beans used commercially, about 90 percent of the cranberry beans, and 60 percent of the yelloweye beans.

Bean growers frequently encounter unfavorable weather during the harvest season. When beans having a high moisture content, are threshed they must be dried before they can be stored without danger of loss in quality. One satisfactory method of drying is forced circulation of unheated air through the beans, at the rate of a minimum of 5 cubic feet per minute (c.f.m.) per bushel. Air temperatures are relatively low during the harvest season, therefore, this method has been found rather slow in reducing the moisture content.

OBJECTIVE

The objective of this study was to develop a method of using forced circulation of heated air for more quickly drying beans without excessive cracking resulting.

PROCEDURE AND EQUIPMENT

In a preliminary trial, air heated to approximately 100° F. was forced through beans of about 20 percent moisture at a rate of about 45 c.f.m. per bushel. This resulted in about 15 percent of the beans having cracks and seemed impracticable.

[1]In cooperation with the U.S.D.A., Production and Marketing Administration, Grain Branch, Washington, D. C.

ARTICLE 35-10

A recirculating drier was then designed which would re-use part or all of the air that passed through the beans. The re-use of this air at a higher humidity did not give as rapid drying as did the drier air in the first test, but fewer cracked beans were produced.

The recirculating drier (Fig. 1) contains a centrifugal fan which can be driven by a tractor or an auxiliary engine to force air up through the perforated floor of the bin. The drying bin had a capacity of 150 bushels. It was completely enclosed so that the air leaving the bin

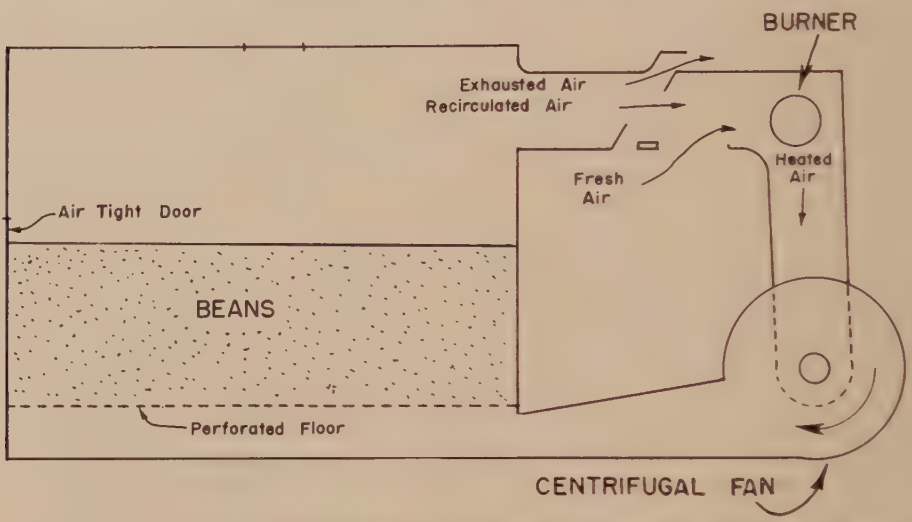

Fig. 1. Sketch of drying bin arrangement for recirculating air in drying navy beans.

in the upper return duct could be exhausted either to the outside or mixed in part with fresh air and returned to the burner for reheating. The proportion of exhaust air that was recirculated was controlled by vanes in the upper return duct. The heated air was drawn through the fan and forced through the perforated floor of the bin and up through the beans. For example, when 25 percent of the air was recirculated, 25 percent of the air that had passed through the beans was returned to the burner for reheating together with 75 percent fresh air from the outside.

PRINCIPLES INVOLVED

When beans are dried with forced circulation of heated low-humidity air, the outside of the bean dries faster than the inside. This causes a more rapid shrinking of the outside than the inside and the

resultant stresses cause the bean to crack. In order to prevent cracking, the rate of drying of the inside must be more nearly equal to that of the outer part. This is accomplished by the use of recirculated heated air which has a higher humidity than heated fresh air. However, the drying period is longer.

TESTS AND RESULTS

Five tests were made on pea beans. These tests involved: 1) no recirculation, 2) 25 percent recirculation, 3) 50 percent recirculation, 4) 75 percent recirculation, and 5) burner on for one-half hour, then off for one-half hour, with the fan operating continuously. Air at the rate of about 90 c.f.m. per bushel, heated to approximately 100° F., was forced through the beans with the fan. This was the lowest volume which could be obtained with the burner used (7150 c.f.m.) with 75 bushels of beans in the bin.

TABLE 1—The effect of recirculation of heated air on the drying of beans

Percent recirculation of heated air	Initial weight of beans (lb.)	Initial moisture percent (W.B.)	Final moisture percent (W.B.)	Percent of beans cracked	No. 3 fuel oil, gal.	Temperature heated air, °F.
None	8,556	20.0	13.2	12 to 18	10.5	102
25	4,200	22.4	16.6	2.50	5.25	98
50	4,500	24.9	15.8	1.75	7.65	100
75	4,300	22.9	16.0	1.25	5.25	100
Burner on ½ hr., off ½ hr., fan on continuously	4,200	22.0	18.0	1 to 5	6.0	99

A definite decrease in cracking was obtained by recirculating the air, as shown in Table 1. It was observed that most of the cracked beans were in the bottom of the drying bin, which was the result of that layer of beans having come in contact with hotter and dryer air than did the beans above them in the bin. The 75-percent recirculation treatment required a drying period three times longer than that of no recirculation of heated air.

The amount of fuel required for drying during the five tests did not vary appreciably. The cost of fuel, based on 15 cents per gallon, was approximately 2 cents per bushel for lowering the moisture content from 25 to 15 percent.

The use of direct heaters in which the products of combustion are drawn through the beans should be avoided. An appreciable amount of smoke damage occurred when a direct heater was used with 50 and 75 percent recirculation.

SUMMARY

Pea beans were dried with air heated to 100° F., both with and without partial recirculation of used air. As the percentage of recirculation was increased, the percentage of cracked beans decreased, the time of drying increased, and the fuel consumption per bushel of beans remained approximately the same. To avoid smoke damage, an indirect heater should be used to heat the air. Drying beans with heated air in a recirculating-type drier is still in the experimental stage, and cannot be recommended on the basis of these trials, but holds promise of accomplishing rapid drying without excessive crackage.

USE OF CORN COBS AS A FILLER FOR CONCRETE USED IN FARM CONSTRUCTION

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IN MANY FARM BUILDINGS, such as poultry houses, dairy structures, and, in some instances, dwellings, the use of regular concrete is impracticable because of its high heat-transmitting ability. This property encourages moisture condensation, which results in undesirable working conditions and poor housing for animals or products stored in the structure. Attempts have been made to develop a concrete for farm construction that has considerably better insulating properties than regular sand-and-gravel concrete. Materials such as saw dust, wood chips, agricultural fibers and other organic materials have been considered but have not been developed for farm use.

In many areas of the Corn Belt large amounts of corn cobs are available. Some of these cobs are being used for fuel, cattle feed, and insulation but, in many instances, they are burned as waste material. Corn cobs have some properties that make them a logical material as a filler in concrete.

PROCEDURE USED IN MAKING CORN COB CONCRETE

Bright, dry cobs, preferably those from which the grain has just been shelled, should be used. Old, muddy cobs that have been exposed to the weather for some time should not be used.

The cobs are ground into pellet form by a hammermill of the type found on many farms. The ground cobs are then screened to remove parts of husks, fine material and pellets too coarse to fall within the desired size range of ⅛″ to ¼″ (Fig. 1). Husks and fine material in the filler tend to accumulate and form a soft surface on the concrete.

After screening to the desired size, the cob pellets are placed in burlap bags and soaked in water for at least 6 hours. To avoid inter-

[1]Work carried on from funds made available through the Research Marketing Act and with the cooperation of the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U.S. Department of Agriculture.

ARTICLE 35-11

Fig. 1. Corn cob pellets screened and soaked, ready for use in concrete.

ference with daytime mixing and pouring, the cobs are left in water over night. When taken from the water the cobs should be allowed to drain for approximately 4 hours to allow any free water to pass off. This is important since any soluble material will drain off, and the amount of mixing water in the concrete can be more easily regulated.

MIXING AND CASTING

All mixtures, both for cast-in-place-concrete and blocks, used in these studies were proportioned by volume. A small barrel-type mixer was used in mixing the concrete for the cast in place sections. All ingredients placed in the mixer were thoroughly mixed for several minutes before being placed in the forms. When blocks were made, a commercial block plant mixed the concrete in a paddle-type mixer and formed the blocks in a vibrating block machine. Previously a tamp-type block machine was tried, but owing to the resilience of the cobs, the blocks were deformed, and were difficult to lay in a wall. Standard practices for curing concrete were used in order to gain maximum strength.

TESTS MADE ON "COBCRETE" SPECIMENS

The following tests were made to determine the characteristics of the concrete produced from the various mixtures (Table 1):

Strength—(First test run)—Standard 6″ x 12″ cylinders for compression and 6″ x 6″ x 21″ beams for tension tests were made. If the mixture exhibited adequate compression strength, additional tests were conducted to determine properties of durability, moisture absorption and capillarity.

Durability—Specimens 3″ x 3″ x 15″ were cast with the threaded end of a bolt projecting from each end. The specimens were then subjected to alternate freezing and thawing from 0° to 75° F. The dimensional change between bolt ends was measured periodically. This change in dimension was used as a measure of durability. A floor and wall section was cast outside for observational studies and after three winters only superficial small surface checks were apparent.

Moisture Absorption—Specimens 6″ x 6″ x 6″ were dried in an oven, weighed and then submerged in water for 24 hours. At the end of that time they were weighed again and the percentage of absorption was computed.

Capillarity—This test consisted of placing 6″ x 6″ x 6″ specimens in shallow pans of water and measuring the rise of water in the specimen after a 24-hour period.

DISCUSSION OF RESULTS

Strength—As recorded in Table 1, the strength of the mixtures tested varied from 274 to 2480 pounds per square inch (p.s.i.) for the 28-day compression test. Mixes having strengths of 800 p.s.i. or more are considered satisfactory for most one-story farm buildings.

The strength varied inversely with the amount of cob pellets used in the mixture. For that reason, the amount of corn cob pellets used in a mix should be determined by the strength requirements of the structure. Supplemental tests indicated that the size of the cob pellets also had some effect on the strength, although not so much as the amount used. It was found desirable to remove the fine particles because they float to the surface to cause difficulties in pouring and finishing the concrete. The most desirable size was between ⅛″ and ¼″ in diameter.

TABLE 1—Test data for "corncob" concrete mixes

Mixture No.	Weight lb./cu. ft.	Compression, p.s.i.		Parts by volume				Percent water absorption	Capillarity, inches	Freezing and thawing cycles	Thermal conductivity (K)
		7-day	28-day	Cement	Sand	Cobs	Hydrated Lime				
2T.....	117.4	1,659	2,480	1	2	1	.....	9.53	3/8	70	5.6
2U.....	110.2	1,224	1,722	1	2	1 1/2	.....	10.08	1 1/8	70	4.9
2V.....	99.5	617	991	A.E. 1*	2	2	.....	12.66	1 3/8	70	4.5
2W.....	93.8	432	809	A.E. 1	2	2 1/2	.....	14.16	5/8	70	3.8
2X.....	87.3	307	522	A.E. 1	2	3	.....	27.21	1 5/8	64	3.6
2Y.....	85.9	262	346	A.E. 1	2	3 1/2	.....	29.50	1 7/8	19	3.0
2Z.....	87.4	454	672	A.E. 1	2	3	1/2	21.86	3/4	70	3.5
3A.....	84.2	167	274	A.E. 1	2 1/2	4	.....	32.05	5/8	25	3.0
3B.....	87.8	562	833	A.E. 1	2	3	1/4	18.76	3/4	70	3.3
3C.....	85.5	201	438	A.E. 1	2 1/2	4	1/2	22.95	1	70	3.4

*Air entraining cement.

Slightly larger pellets may be used, but all smaller than ⅛″ should be removed.

Moisture Absorption—Tests were run to determine water absorption rates, which is an important factor in concrete quality. To develop adequate strength during curing there must be water available to the cement. If pellets absorb appreciable moisture from the mix, the resulting strength will be low. For that reason, it is necessary to soak the cobs adequately before mixing. Corn cobs absorb water rapidly during the first 6 hours, and at a much slower rate for the next 24; hence, soaking beyond 6 hours is of little value.

The tests for durability, water absorption and capillarity were run only when the test specimens passed the strength test. There was a direct relationship between the water absorption, durability, capillarity and the amount of cobs in the mix. Because of those factors it will be necessary to protect the surfaces of the wall or floor made with corn cob concrete with a dense, durable protective coating. If moisture can be prevented from penetrating the surface, the problems arising from high water absorption and low durability can be controlled.

Thermal Conductivity—When the initial tests were completed those mixes showing satisfactory strength and relatively high durability were subjected to tests with a guarded hot plate to determine the thermal conductivity. As shown in Table 1, the heat transfer coefficient (K) varies from 3.0 to 3.6 for the mixes containing significant amounts of cob pellets. The small portion of lime that was added to specimens 3B and 3C resulted in higher strengths than in comparable specimens 2X and 3A. The addition of lime to those mixes having a high percentage of cob pellets and low thermal conductivity (K) is desirable.

Mixture 3B which contained 1 sack of cement, 2 cubic feet of sand, 3 cubic feet of cob pellets and ¼ sack of lime gave the best insulating value with sufficient strength to be of use in farm buildings. The water absorption was 18.76 percent which would necessitate treating the surfaces with some water-repellant material. This mixture weighed 87 pounds per cubic foot, had a 28-day strength of 833 p.s.i. and a "K" value of 3.3 B.t.u./ft.^{2}/°F./hr.

After laboratory tests were completed, arrangements were made with a local block plant to make corn cob concrete blocks on an experimental basis. The mix used was 3.2 cubic feet of cement, 12.5 cubic

feet of sand, 14 cubic feet of corn cob pellets and 1 cubic foot of hydrated lime.

Following the mixing and the forming in a vibrating-type block-making machine the blocks were transported to a steam kiln. Here in a closed room a 2-hour pre-set period was allowed. Then live steam was turned on for about 1½ to 2 hours to bring the kiln temperature up to about 170° F. The steam was then turned off, and the blocks remained in the steam-laden kiln for 24 hours after which they were stock piled in the open air until used in building construction.

FIELD TESTS

In order to determine field performance, a two-sow farrowing house was constructed during June and July, 1951 (Figs. 2 and 3). The following types of wall sections were used:

1) Standard 8″ x 8″ x 16″ 3 core blocks.
2) A 12″ cavity wall using 2 walls of 4″ x 4″ x 16″ solid blocks with a 4″ space in the center filled with ground cobs.
3) A 12″ thick monolithic wall of corn cob concrete.

Fig. 2. Exterior of farrowing house made with corn cob concrete.

The floor was divided into two sections, one-half having a standard 4″ concrete floor and the other half with a 2″ sub-floor of corn cob concrete with a 2″ finish floor of regular sand and gravel concrete.

A standard ¼ pitch gable roof was used. The ceiling was surfaced with a ¾″ fiber insulation board below the joists and 2 inches of corn cob pellets between the joists.

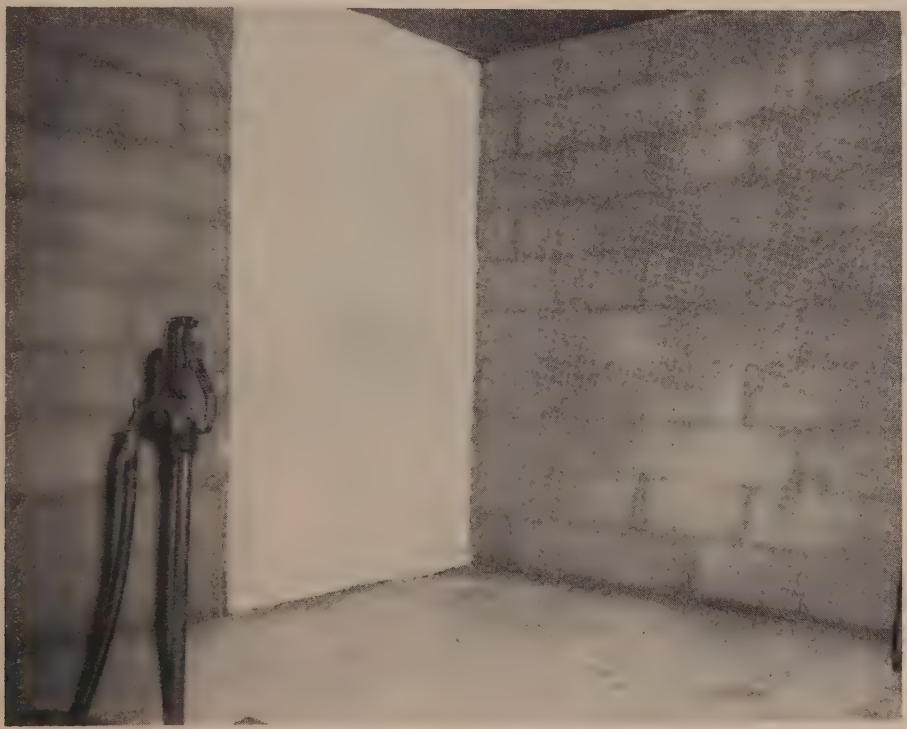

Fig. 3. Interior of farrowing house, showing some of the different types of wall finishes.

Because of the high moisture absorption characteristics some method of treatment of the exterior and interior wall surfaces had to be used. No sealer was necessary for the floor. Several treatments were used. At present, the most satisfactory surface coating for walls is one coat of cement-sand grout to smooth the surface, two coats of Portland cement paint and one coat of a clear masonry sealer (Fig. 4). No information is available at this time on the performance of the structure under winter conditions.

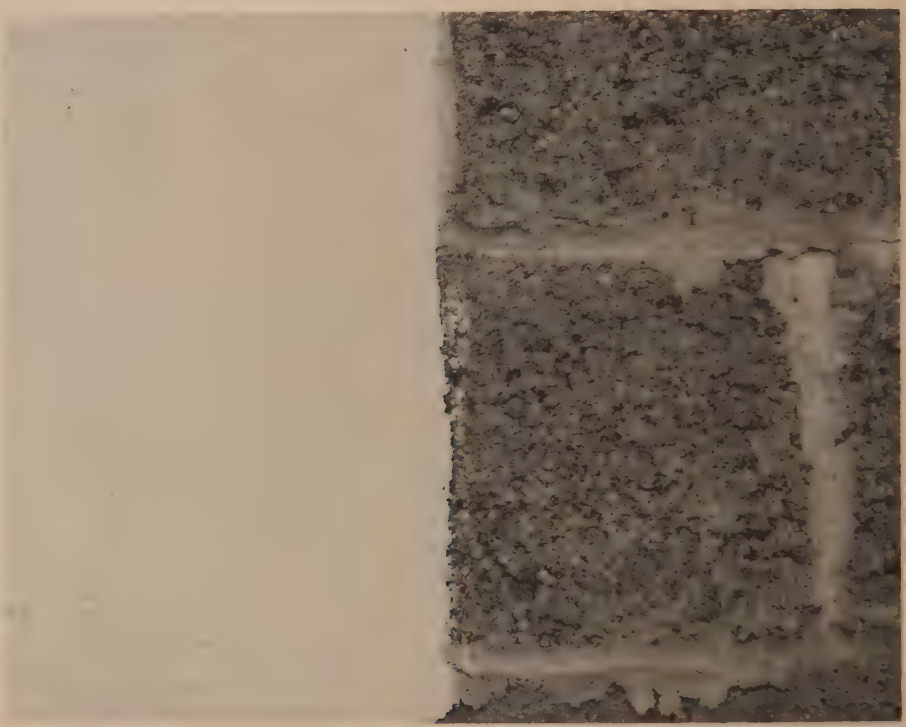

Fig. 4. Close up of wall, showing the painted and unpainted surface of the wall.

OTHER WORK USING CORN COBS IN CONCRETE

Recent reports have come to the writers' attention that there are at least two commercial organizations in United States working with corn cob concrete having a weight as low as 45 pounds per cubic foot and which tests from 1000 to 15000 p.s.i. compressive strength.

Methods of construction using this material are being worked out to simplify the erection of structures using a light-weight concrete.

As a result of this work and that of others, it seems likely that corn cob concrete may be successfully used as a material for farm building construction.

AN ANTIFUNGAL PRINCIPLE IN THE CELL OF *ACHROMOBACTER IOPHAGUM*

By GUEH-DJEN HSIUNG[1] *and E. H. LUCAS*
DEPARTMENT OF HORTICULTURE

THE ABILITY of certain antibiotic substances to inhibit the growth of various fungi has been reported previously (1-7). Although a large number of substances is thus known to have definite activity, their usefulness is determined by the degree of their toxicity. Some, as actinomycin (1), are extremely toxic; others, as clavacin (2), less so. Only a few appear to offer definite promise for the practical control of fungus infections (3, 4, 5, 6, 7).

Bowling and Wynne (8) found that 14 aerobacter strains possessed varying degrees of antagonism against seven test organisms. Two methods of killing aerobacter cells destroyed the activity. Filtrates and dialysates were inactive. The authors postulated that the antagonistic property is closely connected with the living cell.

In the course of a screening program dealing with higher fungi there was isolated from a sample a species of the genus *Achromobacter* which possessed considerable fungistatic properties, as evidenced in plate tests (Fig. 1). As far as the authors are aware, this organism has not been mentioned previously in the literature on antibiotics. The present report is of a preliminary nature. Chemical studies and fungicidal activity *in vivo* will be the subjects of further research and subsequent reports.

DESCRIPTION OF THE ORGANISM

Morphology—The organism, a gram-negative bacillus, was isolated from a fresh morel specimen on solid medium. The colonies were circular and amoeboid, with irregular edges on potato dextrose agar (Difco). Motility medium showed positive results after 24-hour incubation at 28° C. No pigment was produced in either solid or liquid media.

[1]At present: Bacteriologist, Wene Poultry Laboratories, Pleasantville, New Jersey.

ARTICLE 35-12

Biochemical reactions—Nitrates were reduced to nitrites, and starch was hydrolyzed. Acid was formed from dextrose, mannite, sucrose, glycerol and trehalose. No fermentation was observed in lactose, maltose and sorbitol. Gelatin was liquefied after 24 hours of incubation. Indol was not formed, and litmus milk was unchanged. Growth was abundant at 28° C. but poor at 37° C. The organism was identified as *Achromobacter iophagum* according to Bergey's Manual of Determinative Bacteriology (9).

ANTIBIOTIC ACTIVITY

Potato dextrose broth[2] was selected as medium for production of the active principle. The broth culture was filtered through a Seitz filter or glass filter.

Cell-free filtrates, tested for presence of the active principle, were found negative. Precipitation by means of ethanol or acetone did not produce an active fraction. Charcoal adsorption failed to yield an active principle in either the eluate or the filtrate.

The living cells were treated in various ways to secure a suitable method of killing without destroying the active substance.

Penicillin (100 units per ml.), streptomycin (0.002 percent) and formalin (0.05 percent) did not kill the organism. Before the organism was identified, phenol (0.05 percent) was also used and likewise failed to kill it; this fact was substantiated by the identification which revealed that the organism was a phenol-resistant species. Exposure to ultraviolet light for 10 minutes was ineffective.

Aureomycin (1 percent), 70 percent ethanol and absolute ethanol killed the organism but also destroyed the active substance; so did heating at 40° C. for 15 minutes or exposure to ultraviolet light for 30 minutes.

Ethyl ether, acetone, chloroform and 40 percent glycerine, however, were used successfully in killing the organism without destroying the active principle.

Both the living culture and the killed cells were tested against *Micrococcus pyogenes* var. *aureus*, *Micrococcus pyogenes* var. *albus*, *Bacillus subtilis*, *Serratia marcescens*, *Escherichia coli*, and *Salmonella pullorum*. No inhibition of any of these species was shown.[3]

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[2]Potato dextrose broth formula: Fresh potatoes were used, 500 g. being cut into small pieces and steamed in one liter of distilled water for 30 minutes. The liquid was poured through cotton gauze and then filtered through paper. After making to volume, 2 percent dextrose was added. The broth was autoclaved at 15 pounds pressure for 20 minutes.

[3]The authors are indebted to Mrs. Ivory Johnson, Department of Bacteriology and Public Health, Michigan State College, for performing these tests.

The living culture was tested against common mold contaminants, as *Penicillium* sp., *Trichoderma* sp., *Aspergillus* sp., and *Alternaria* sp. These were clearly inhibited by the presence of *Achromobacter iophagum* (Figs. 1 and 2).

Organisms isolated from raspberries[4] such as *Alternaria humicola, Trichoderma viride, Helminthosporium anomalum, Penicillium* sp., *Phoma* sp., and *Pullularia pullulans* were more or less inhibited by the growth of *Achromobacter Iophagum.*

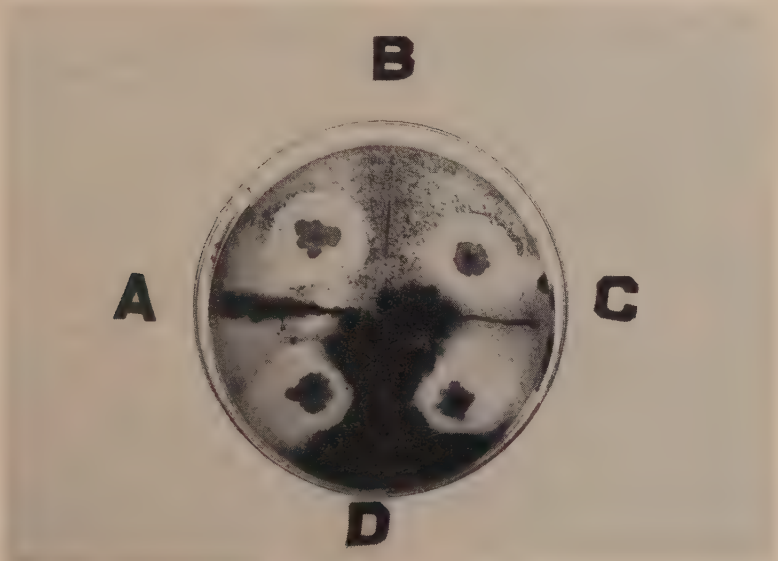

Fig. 1. Inhibitory action of *Achromobacter iophagum.*

A. *Penicillium* sp.
B. *Trichoderma* sp.
C. *Aspergillus* sp.
D. *Alternaria* sp.

TOXICITY

Living broth culture was injected into mice intraperitoneally. No untoward reactions of the animals were observed.

Cucumber seeds were germinated on filter paper in eight Petri dishes. Five-tenths of a milliliter of a 0.2 percent spore suspension of *Aspergillus niger* was placed in each of six dishes. To four of them 10 ml. of broth culture of *Achromobacter iophagum* was added. In

[4]These cultures were obtained through the courtesy of Dr. E. S. Beneke, Department of Botany and Plant Pathology, Michigan State College.

the other four dishes distilled water replaced the broth culture. No growth of *A. niger* was observed in the presence of the broth culture, while it took place in the dishes with distilled water. However, growth of main roots as well as laterals of cucumber was somewhat inhibited by the *Achromobacter* culture.

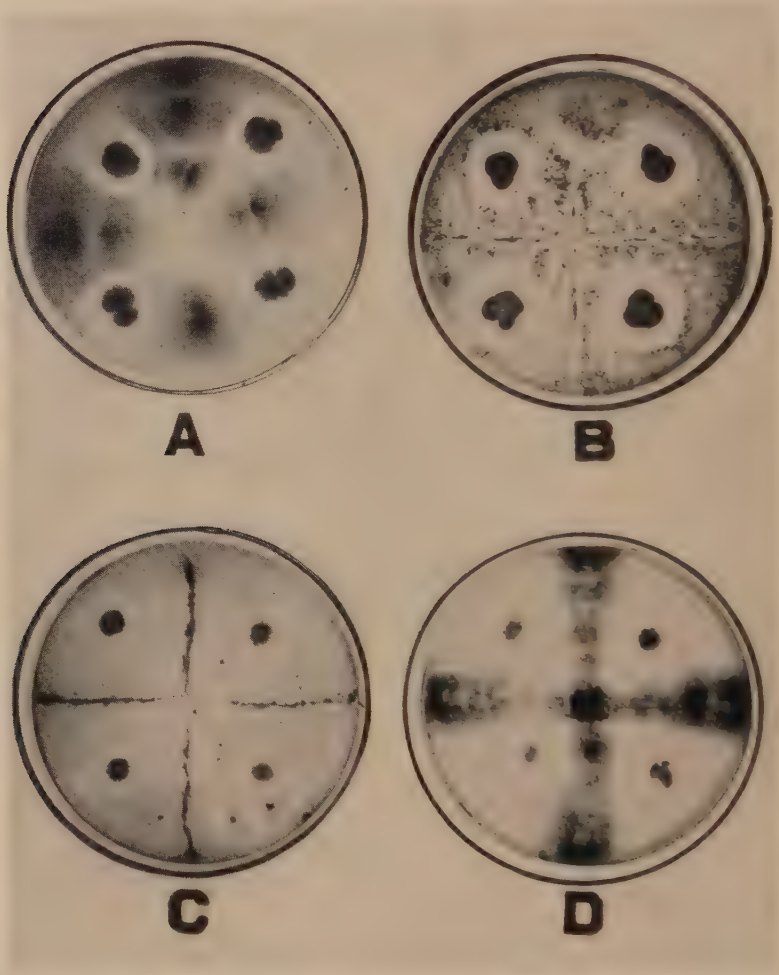

Fig. 2. Inhibitory action of the active principle of *Achromobacter iophagum* given off by living cells.

A. *Aspergillus niger* inhibited by the circular colonies of *Achromobacter iophagum* incubated at 28° C. for one week.

B. *Trichoderma sp.*, ditto.

C. *Aspergillus flavus* inhibited by the circular colonies of *Achromobacter iophagum* incubated at 28° C. for 4 days.

D. *Alternaria humicola*, ditto.

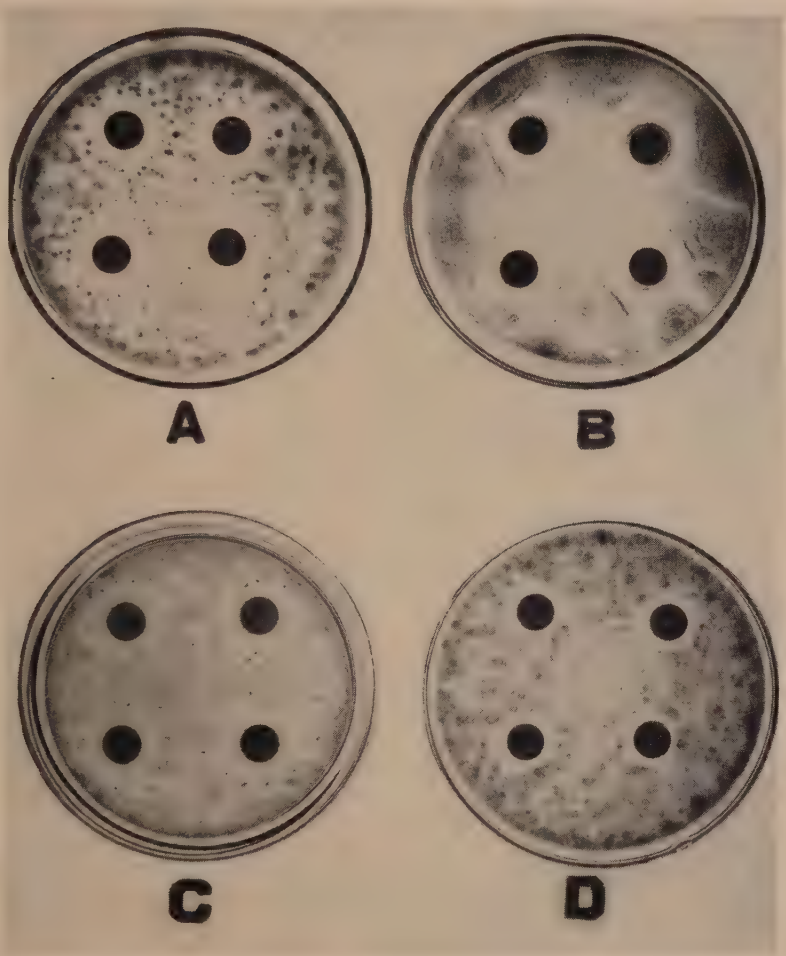

Fig. 3. Inhibitory action on *Aspergillus niger* of the active principle of *Achromobacter iophagum* incorporated into paper disks.

A. Cells treated by grinding with celite for 15 minutes.
B. Cells treated by grinding with celite for 30 minutes.
C. Broth culture treated with ether for one hour.
D. Cells treated with 40 percent glycerine for 24 hours.

SEPARATION OF THE ANTIBIOTIC PRINCIPLE AND METHOD OF TESTING

The organism was inoculated into potato dextrose broth and incubated at 28° C. for 5 to 7 days. The cultures were removed from the incubator, and ether was added at the ratio 1:10 (1 part of ether to 10 parts of broth culture). This procedure served two purposes: The

organism was killed, and the cell material was extracted into the ether layer which was separated by means of a separatory funnel. The ether was then evaporated and the crude cell material obtained.

Ordinary centrifugation was not successful in separating the bacterial cells. Refrigeration and ultracentrifugation were employed, but not all the cells segregated from the broth within 60 minutes.

Lyophilization was used to dry the broth culture. The material thus obtained was a white powder consisting of living cells.

Grinding techniques for cells (10) were used to break the dehydrated material. Celite No. 503 was the abrasive used, and the cells were ground in a Cori-type metal homogenizer (11). From Fig. 3 (A, B) it can be seen that after a certain period of grinding an antibiotic substance is released. The results indicate that the longer the period of grinding the better is the inhibition. Grinding, however, did not kill all of the cells.

The dry cell material was also treated with 40 percent glycerine for 24 hours. The organism was killed without any appreciable loss of activity (Fig. 3 [D]).

For the purpose of the present investigation, which was qualitative rather than quantitative, a simple paper disk method of estimating antibiotic action was used. One-tenth milliliter of a standardized spore suspension of *A. niger* was placed in a sterile Petri dish. Ten ml. of melted Difco potato dextrose agar was added and mixed thoroughly with the suspension. After the agar had solidified, four sterile paper disks (S & S No. 740-E, 12.7 mm.) were laid on the surface of the agar. To each paper disk 0.05 ml. of a water suspension of the killed cell material was added. The Petri dishes were incubated at 28° C. and the results determined after 48-96 hours (Fig. 3). Cylinder methods were also used, but the paper disk method gave better results.

SUMMARY

A strain of *Achromobacter iophagum* has been isolated which elaborates a previously undescribed antibiotic principle. The antagonism is closely allied with the living or dead cell of the organism. This antibiotic possesses marked antifugal activity but is inactive against bacteria. The fungus spectrum of antagonized organisms includes many of the common mold contaminants. No toxicity of this agent toward animals was observed. A satisfactory bioassay employing the paper disk method with a spore suspension of *A. niger* is described.

Research is being continued to elucidate the chemistry of the active principle.

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CHEMICAL TREATMENT OF POTATO SLICES IN RELATION TO THE EXTRACTION OF SUGARS AND OTHER DRY MATTER AND THE QUALITY OF POTATO CHIPS

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TO OBTAIN consumer acceptance, potato chip manufacturers must market a product which meets the standards of appearance commonly associated with good flavor and texture. A light golden brown color, without apparent greasiness, has general public approval.

In a previous paper (2), it was shown that great improvement in color could be accomplished by giving potato slices a short, warm (140-160° F.) water treatment, followed by soaking in cold water. Chemical analyses showed that the reducing sugars, which cause coloration (1), were extracted from the slices by this treatment. In 15 minutes of extraction practically all of the reducing sugars, about 35 percent of the protein and about 7 percent of the total dry matter were removed.

In the present series of experiments, potato slices were treated with various harmless chemicals in an attempt to injure the plant membrane systems sufficiently to allow diffusion of reducing sugars, while avoiding unnecessary loss of dry matter. Three classifications of chemicals were used: fat solvents (ether, alcohol); concentrated solutions (common salt); active ions (hydrogen ion in mineral acids). Following a short treatment in water solutions of these chemicals, the slices were placed in water to allow outward diffusion from the slices.

EXPERIMENT 1

In the winter of 1950 Pontiac potatoes were stored at 40° F. for 15 days to accumulate a high percentage of reducing sugars in the tubers, in order to assure a uniformly dark color of the chips from untreated slices. Samples of uniform slices were treated at room temperature and at 140° F. for 5 minutes with the following solutions:

ARTICLE 35-13

1) Saturated salt solution, 2) acetic acid, 1 percent, 3) ethyl alcohol 1 percent, 4) ethyl ether 1 percent, and 5) water. After treatment, the slices were thoroughly washed in running water to remove all trace of the chemicals, and then fried in Primex[1] at an initial temperature of 385° F. and a removal temperature of 355° F.

Photographs of representative samples of chips from the various treatments are shown in Fig. 1. The color was markedly reduced by

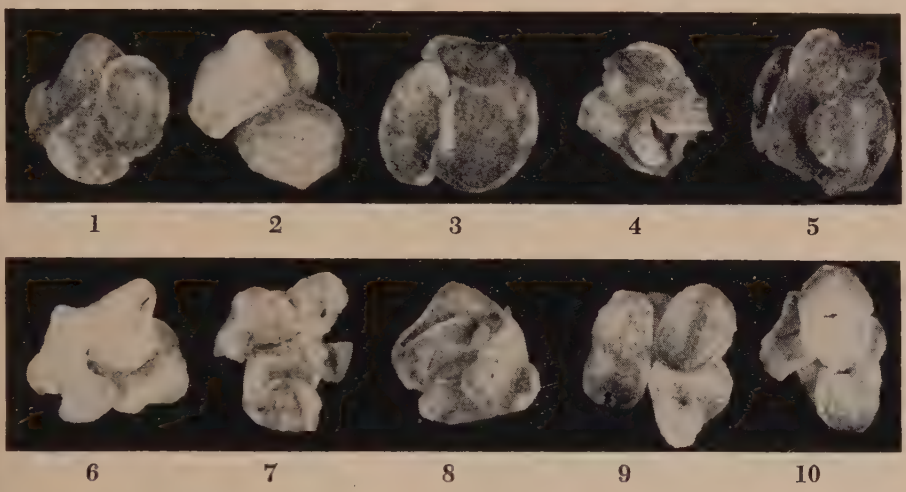

Fig. 1. Appearance of potato chips after frying. Before being fried, the raw potato slices were treated for five minutes, at temperatures of 70° and 160° F. with various solutions, followed by thorough washing in water.

Top Row, 70° F.: 1—saturated salt solution; 2—acetic acid 1 percent; 3—ethyl alcohol 1 percent; 4—ethyl ether 1 percent; 5—distilled water.

Bottom Row, 160° F.: 6—saturated salt solution; 7—acetic acid 1 percent; 8—ethyl alcohol 1 percent; 9—ethyl ether 1 percent; 10—distilled water.

all treatments at the higher temperature (160° F.), but at the lower temperature (70° F.) only for those chips treated with 1 percent acetic acid or 1 percent ether. When the slices were treated with saturated salt solution the color was improved but the chips appeared greasy.

EXPERIMENT 2

On the basis of these observations, further treatments were made with the 1950 crop with several concentrations of sulfuric, hydrochloric and phosphoric acids at various temperatures. In general, concentrations of 1 percent or more resulted in very dark, charred chips.

[1]A Procter and Gamble product.

Concentrations below 0.25 percent appeared to be most satisfactory, with dilutions as low as 0.01 percent being clearly effective.

In Fig. 2 are shown photographs of chips following treatment with water and dilute phosphoric acid; as follows:

1. Water for 8 minutes at 75° F., 130° F., and 140° F.
2. Phosphoric acid at the dilutions shown for 3 minutes at 75° F., 130° F. and 140° F., followed by washing in water at the same temperatures for 5 minutes.

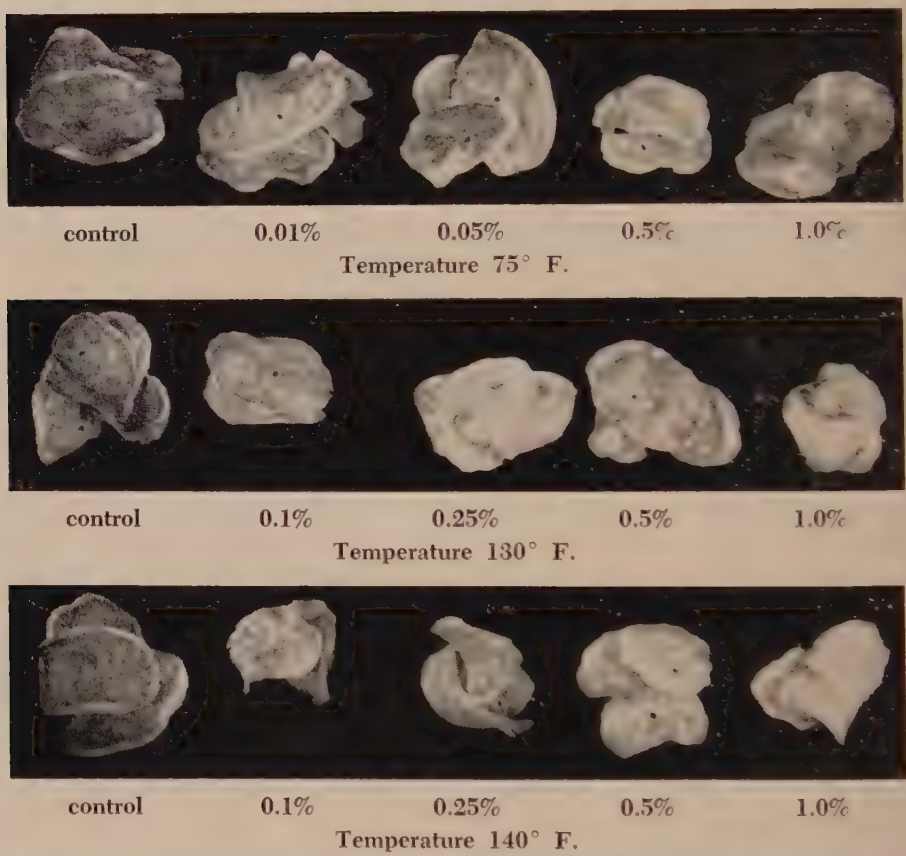

Fig. 2. Appearance of potato chips after frying. Before being fried, Pontiac potato slices were given a 3-minute dip in phosphoric acid at the concentrations and temperatures shown above, followed by washing in running water for 5 minutes.

In general, the higher the temperature of acid treatment, the lower the concentration of acid required to give the desired degree of decoloration. Treatment with dilute acid was more effective than other-

wise comparable treatment with water alone in all cases. Over-treatment tended to produce greasy chips, which generally were thin and curled.

In the early spring of 1951, tests in cooperation with the New Era Potato Chip Company, Detroit, Michigan, showed that treatment of slices with 0.1 percent phosphoric acid for 3 minutes, previous to the standard washing in water, resulted in chips of an acceptable color whereas untreated slices produced chips that were too dark for commercial acceptance.

Various lots of potato slices from the slicer at the Adams Potato Chip Company, in Lansing, Michigan, were treated with various low concentrations of hydrochloric and phosphoric acids for 3 minutes, previous to washing and frying in their machine. These chips, of excellent color and texture, were packaged by them in order to observe "shelf life". They reported that there appeared to be no deviation from the behavior of chips from untreated slices.

EXPERIMENT 3

In this experiment, an attempt was made to determine quantitatively the degree of extraction of dry matter, sugars and proteins from potato slices treated with dilute hydrochloric and phosphoric acids.

Ten U.S. No. 1 Russet Rural potatoes, with a specific gravity between 1.076 and 1.088 were selected. They had been grown on sandy soil, from a crop planted May 4 and harvested September 7, 1951. Potatoes of this character, when properly stored, can be expected to make good chips. They were stored at about 60° F. for 3 months, before being placed in the refrigerator at 45° F. for the 15 days immediately preceding the experiment. This cold treatment was given to produce moderate darkening in otherwise satisfactory chips.

Twenty, 30-gram samples were prepared, each consisting of one slice from each of the 10 tubers. Two samples were used to determine the total percentage of dry matter and total percentage of protein in the slices. The other 18 samples in six lots of three were extracted as follows with acid solutions and with water. Solutions of hydrochloric acid pH 1.9 (about 0.05 percent) and phosphoric acid (pH 1.9) were prepared. Eighteen beakers were prepared, six each with 100 cc. of water, hydrochloric acid and phosphoric acid respectively. Three of each six were heated to 75° F., the other three to 120° F. The potato samples were immersed for 1½ minutes in the prepared solutions.

TABLE 1—Treatment of potato slices

Raw potato slices were treated for 1 ½ minutes with water, hydrochloric acid pH 1.9, or phosphoric acid pH 1.9 at 75°F. or 120°F., after which they were extracted with water at the same temperatures for 3 ½ minutes. Analyses of the water extracts and of the extracted solids are given to show the loss of sugars, protein and total solids in the extraction process. The chips produced by frying after extraction were graded for color, 1 very dark to 10 almost white, with a grade of 7.5 to 10 being acceptably light in color.

Sample	Analysis of Extracts				Analysis of extracted slices		Chip color rating	pH solution after extraction
	Total solids extracted as		Protein extracted as		Total sugar	Reducing sugar		
	Percent slices	Percent solids	Percent slices	Percent protein	Percent slices	Percent slices		
Water 75°F.....	0.91	4.32	0.156	5.49	1.88	0.10	5.1	7.45
Water 120°F.....	1.19	5.69	0.313	10.98	1.44	0.08	6.2	7.55
Hydrochloric acid 75°F.....	1.06	5.06	0.275	9.68	1.75	0.05	7.3	2.65
Hydrochloric acid 120°F....	1.34	6.40	0.375	13.16	1.27	0.00	9.2	3.15
Phosphoric acid 75°F.....	1.30	6.22	0.256	9.00	1.57	0.04	8.2	2.20
Phosphoric acid 120°F.....	1.61	7.68	0.384	13.49	1.35	0.00	9.8	2.45
Unextracted slices.....	T.S. % 20.92		T.P. % 2.85					

They were then removed and given an additional period of extraction for 3½ minutes in 100 cc. of water at the same temperature at which treatment had been given.

After extraction, two samples from each group of three were fried. The other sample was analyzed for sugars. The extracts from each group of three were combined and analyzed to determine the amount of solids and protein (Kjeldahl nitrogen x 6.25) extracted from the slices. The pH of the acid solutions was determined after treatment of the samples had been completed.

Table 1 shows the results of the analyses. Figure 3 shows photographs of the chips. The slices in the sample designated "water 75°"

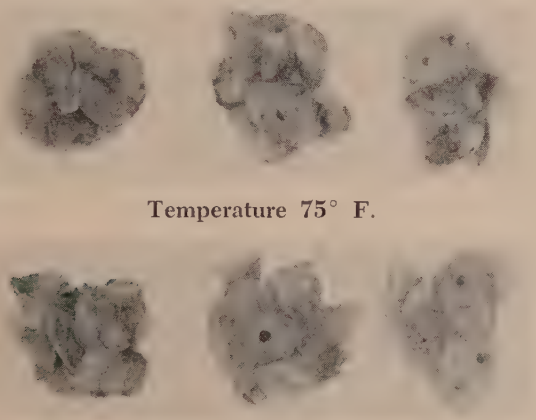

Fig. 3. Chips were made from raw potato slices that were treated as indicated above for 1½ minutes, followed by washing for 3½ minutes before being fried.

may be considered untreated checks, since they were merely soaked in water at room temperature for 5 minutes. It may be seen that simply soaking and washing in water at 75° F. for 5 minutes removed 4.3 percent of the solids, and that this was increased to 5.69 percent by raising the temperature to 120° F. Acidification of the water resulted in further increases in solids extracted. In a more or less parallel way, extraction of protein was increased either by raising the temperature or by acidification.

Losses of dry matter in the potato slices, owing to the most severe acid treatment were 7.68 percent of the total solids or 3.36 percent more than that with washing with water at room temperature. Thus, about 1/30 of the solids of the slices was lost, owing to the most severe acid treatment. The increased loss of protein due to acid treatment was about 1/12 of the total protein. Further experiments were made with Pontiac compared with Russet Rural potatoes, and with Russet Rurals of high specific gravity compared with those of low specific gravity, to determine the degree of extraction of dry matter from slices following treatment with phosphoric acid (0.1 percent). From the Russet Rurals, 1.43 percent and from Pontiacs 0.97 percent of the dry matter was extracted. From Russet Rurals with high specific gravity 1.58 percent and from those with low specific gravity 1.07 percent of the dry matter was extracted. It is well recognized that the potato varieties differ in chemical composition; so also do potatoes of the same variety, with different specific gravities. Thus, no one treatment will produce identical results with various lots of potatoes.

DISCUSSION

Apparently, it is possible to achieve differential extraction of soluble materials, since reducing sugars were completely removed by treatments that removed but 30 percent of the total sugars. Similarly, extraction of "protein" fractions was greatly reduced in these experiments in comparison with extraction following treatment with hot water, in a previous experiment (2). Although it has been suggested repeatedly (3) that various amino acids are partially responsible for darkening of chips, the degree of nitrogen extraction in this experiment seems poorly correlated with color improvement.

In any case, this method which involves only the control of temperature or acid concentration—or both—appears well adapted to remove reducing sugars without great loss of other soluble constituents. Seemingly, the treatment can readily be modified to suit the requirements of various lots of potatoes. To improve the color of potato chips, Whiteman (4) has recently suggested a concentration of 0.044 percent hydrochloric acid as a one-minute dip, and has recommended it for commercial trials. This concentration is well within the limits that the authors have found effective.

From the experience with potatoes of various varieties, specific gravities and storage treatments, the authors believe that no one treatment can be considered adequate for all cases. There is real danger of

overtreating slices, and of producing chips too free from color. Conversely, in potatoes that require rather severe treatment, the losses of solids in extraction may lead to appreciable loss in yield of chips, or unduly tender, brittle chips.

In the case of these various treatments where injury to the plant membrane system has been caused, considerable loss of turgidity or crispness in the slices is evident. For example, potato slices when immersed in brine become limp in a few seconds. A loss of crispness is also observable in treatment with dilute acids. Presumably, water is lost from the slices and is not regained in the subsequent washing in water. As a result of this loss of water from the slices, they appear to fry materially more quickly than do untreated slices. Such a shortened period in cooking would need to be considered in commercial production of potato chips.

SUMMARY

Potato slices were treated with water solutions of ether, alcohol, salt and various dilutions of acids in order to increase the permeability of the plant membranes. By suitably mild treatment, it was hoped that differential extraction of solutes might be accomplished, so that reducing sugars, which are largely responsible for darkening during frying, might be removed by washing without excessive removal of other cell contents. By suitably adjusting the temperature and the concentration of the acid during treatment, acceptably colored chips were made. Russet Rural potatoes that made moderately dark chips were treated in phosphoric or hydrochloric acid at pH 1.9 for 1½ minutes, followed by 3½ minutes washing in water, to give chips of excellent color and texture at either 75° or 120° F. Chemical analyses of extracts and extracted slices showed to what extent the sugars, proteins and solids were removed under different conditions.

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BLOOD AND MEAT SPOTS IN CHICKEN EGGS

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MANY EGGS that appear normal in structure must be classified as inedible because foreign material has been incorporated in them during their formation. Most of these inclusions originate within the body of the bird and are subsequently called blood or meat spots. No housewife likes to find blood or meat spots in an egg. Her unfavorable reaction means fewer eggs consumed and less demand for the product.

It has been estimated that 2 to 4 percent of all eggs contain blood or meat spots. This estimate is based on large spots which can be detected by candling. From 1942 to 1948, about 1½ percent of all eggs candled at one Michigan egg-buying station were classified as "loss" (Dawson and Davidson, 1949). Most of these were inedible because of large blood and meat spots. On the basis of 1½ percent loss, the poultrymen of Michigan in 1950 received $770,000 less for their eggs than they would have if all eggs were free from large spots.

CAUSE OF BLOOD AND MEAT SPOTS

Until recently, meat spots were frequently explained as bits of tissue from the hen's oviduct which had become incorporated into the egg. Blood spots were assumed to have been formed at the time of ovulation owing to the rupture of a small blood vessel across or near the stigma of the yolk follicle in which an egg yolk develops. Nalbandov and Card (1944) reported that bleeding may occur at time of ovulation, but such an occurrence is so seldom that it is not a common cause. Their observations showed that bleeding was intrafollicular and may occur a number of days previous to ovulation. Burmester and Card (1938) and Nalbandov and Card (1944) observed that most meat spots were degenerated blood spots. The difference in appearance of the spots was reported to be a chemical change caused by changes in

ARTICLE 35-14

the pH of the egg white. This change is hastened at high temperatures. They found that a blood spot could change to a white meat spot in egg white held at 88° F. for 8 days. Jeffrey and Pino (1943) and Jeffrey (1945) supplied evidence to confirm this theory.

FREQUENCY OF SPOTS

During 1949 and 1950, eggs from 20 Michigan farms were broken and observed for blood and meat spot incidence (Dawson, Davidson and Sheppard, 1951). As the season progressed (September to August) the incidence of spots increased. The percentage of blood or meat spots was considerably higher in all breeds laying brown-shelled eggs than in Leghorns. In the summer when this incidence was highest, 12 percent of the Leghorn eggs had spots, while 37 percent of the Rhode Island Red eggs and 47 percent of the Barred Rock eggs had some spots (Table 1). The incidence of spots detected by candling was about the same for each breed.

TABLE 1—Seasonal variation in incidence of blood and meat spots

Season	Breed		
	Leghorns	Rhode Island Reds	Barred Rocks
	(percent of eggs with spots)		
Fall	8.3	20.8	29.2
Summer	12.5	37.5	47.5

Only 5.8 percent of all eggs from one strain of Leghorns contained spots, whereas 13.3 percent of the eggs from another strain of Leghorns had some spots (Table 2).

TABLE 2—Strain variation in incidence of blood and meat spots

Strain of Leghorns	A	B	C	D	E
Number of flocks	4	6	1	1	1
Percent eggs with spots	6.3	11.0	8.1	13.3	5.8

In 1951 a study of egg quality was started on a number of Michigan R.O.P. breeding farms. Incidence of spots varied considerably among

breeds and strains within each breed. Table 3 is based on observations from a broken out sample of eggs from each of these farms.

TABLE 3—Breed and strain variation in incidence of blood and meat spots

Breed	Eggs	Eggs with spots
	(number)	*(percent)*
White Leghorn	145	5.52
White Leghorn	39	7.69
White Leghorn	128	16.41
White Leghorn	232	15.95
White Leghorn	142	9.15
White Leghorn	98	19.39
White Leghorn	108	24.07
White Rocks	45	42.22
White Rocks	120	66.67
White Rocks	315	65.71
Rhode Island Reds	81	55.56
Rhode Island Reds	82	63.41
New Hampshires	85	52.94

Leghorn eggs contained fewer spots than the brown-shelled eggs from White Rocks, Rhode Island Reds and New Hampshires.

Eggs from four pens of New Hampshires at the College farm were observed for blood and meat spot incidence. The birds were all grown on range, each pen coming from a different pasture lot with a slightly different feeding program. After housing, all birds were fed alike. Eggs were broken and observed one day each week for 15 weeks.

Incidence of spots was similar for each pen except pen 3 which had three percent fewer blood spots and less than half as many large spots of all colors (Table 4). Further trials are necessary before it

TABLE 4—Blood and meat spot incidence of 4 pens of New Hampshires, January to March, 1951

Pen	Eggs	All spots		Blood red spots		All large spots	
	(number)	*(number)*	*(percent)*	*(number)*	*(percent)*	*(number)*	*(percent)*
1	560	368	65.7	113	20.2	14	2.5
2	608	395	65.0	122	20.1	17	2.8
3	657	415	63.2	112	17.0	7	1.1
4	613	403	65.7	121	19.7	17	2.8
Totals	2,438	1,581	64.8	468	19.2	55	2.3

can be said that the growing ration affects subsequent blood or meat spot incidence.

During the time of these observations the incidence of blood spots among hens varied from 0 to 100 percent. One hen that laid 21 eggs had large blood spots in 15 eggs and small pinpoint blood spots in the remainder of her eggs.

Jeffrey (1945) observed all the eggs from November 1 through August 31 from 166 pullets. Forty of the 166 birds were Rhode Island Reds maintained on the floor. The remainder were in laying cages, and consisted of 24 Legbars, 24 White Leghorns, 24 Barred Rocks and 54 Rhode Island Reds. A total of 23,385 eggs were broken and examined. Table 5 shows the variations found in percentage of blood spots and total spots.

*TABLE 5—Percentage of blood spots and total spots**

Breed	Eggs	Blood spots	Total spots
	(number)	*(percent)*	*(percent)*
Rhode Island Reds in cages	7,707	7.0	61.6
Rhode Island Reds on floor	6,133	5.7	52.0
Barred Rocks	3,282	3.5	62.9
Legbars	2,694	2.4	20.1
White Leghorns	3,569	4.6	12.7

*Source—Jeffrey, 1945.

He found that blood spots were most numerous at the start of the laying year and least numerous at the end of the year (August). Colored meat spots were very common in brown eggs from heavy breeds, less common in tinted eggs from Legbars, and rare in white eggs from White Leghorns.

Van Wagenen, Hall and Wilgus (1937) found a slightly higher incidence of blood spots (than Jeffrey) but a similar incidence of total spots in most heavy breeds (Table 6).

The variation in percentage of blood spots indicated in Tables 4 and 6 may have been due to the difference in strains of New Hampshires or the standard used in classifying spots.

Blood spot incidence was similar for all breeds but meat spot incidence varied greatly.

Nalbandov and Card (1944) found that when hens were confined there were significant increases in incidence of blood spots as the season advanced from December to July. A similar seasonal pattern

*TABLE 6—Breed variations in incidence of meat spots, blood spots and total spots**

Breed	Eggs	Meat spots	Blood spots	Total spots
	(number)	*(percent)*	*(percent)*	*(percent)*
White Leghorns	1,816	11.7	8.1	19.8
Barred Rocks	395	36.2	8.9	45.1
White Rocks	220	40.0	8.6	48.6
Rhode Island Reds	370	44.3	9.4	53.7
New Hampshires	242	48.3	8.7	57.0

*Source—Van Wagenen, Hall and Wilgus, 1937.

was observed in the study of egg candling records from an egg grading station (Dawson and Davidson, 1949). These findings contradict the findings of Jeffrey as reported above.

Most of the evidence presented indicates that the incidence of blood red spots is similar for eggs of all breeds. However, the White Leghorn eggs have very few light-colored meat spots, whereas the brown eggs produced by the American breeds have many such spots. Blood spot incidence tends to increase as the laying year progresses.

FACTORS AFFECTING BLOOD SPOT INCIDENCE

ENVIRONMENT AND FEED

Unsuccessful attempts were made by Nalbandov and Card (1944) to prevent hemorrhages by feeding additional vitamins A, C, D, E, K and P. They found that size and number of blood clots diminished rapidly when hens were turned on range but found no nutritional cause for this change.

Carver and Henderson (1948) found that neither rutin and ascorbic acid nor alfalfa had a significant effect on the incidence of spots in hens' eggs.

Jeffrey and Pino (1943) studied environmental factors (frightening birds with dogs) and genetic factors in relation to the incidence of blood spots. Fright did not increase the number of spots, and it appeared reasonably clear that blood spots are dependent primarily on genetic factors.

INHERITANCE

Lerner and Smith (1942) by candling found 0.516 percent blood spots in 152,510 White Leghorn eggs in their first year. From a study

of the pedigrees of these pullets, they reported that the sires producing most pullets which laid eggs containing spots had a common origin. Thus, they concluded that both seasonal and hereditary differences between birds contribute to a difference in the incidence of blood spots.

Quinn, Godfrey and Lee (1948) reported that 61.9 percent of the eggs of a strain of Rhode Island Reds had blood spots. Selection was effective in the first generation, causing immediate divergence into high and low incidence lines. After 6 years of breeding, the line with the high incidence averaged about 80 percent blood spots; the low incidence line about 20 percent.

Lerner, Taylor and Lowry (1951) developed a blood spot line of White Leghorns in which the percentage of blood spots (detected by candling) increased from 0.54 percent in 1938 to 22.8 percent in 1948. They concluded that to control this defect by genetic practices, combined family and individual selection procedures should be employed.

LOCATION OF SPOTS

The position and color of all spots from 2,438 New Hampshire eggs from the College flock were recorded. As mentioned earlier, 64.8 percent of the eggs contained some spots. Forty-eight percent were on the yolk, 27 percent were floating free in the albumen and 25 percent were in the chalazae. Figure 1 shows the distribution of the spots observed by location within the eggs. Spots were found in only one

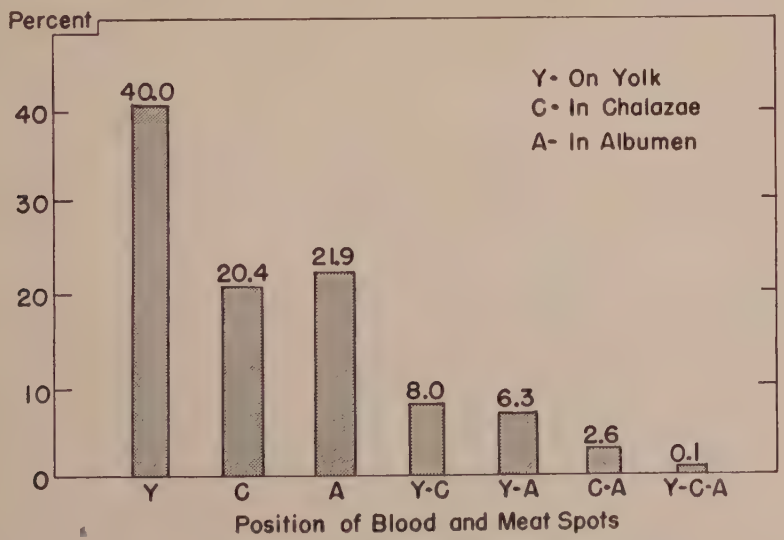

Fig. 1. Position of blood and meat spots within eggs.

position in over 80 percent of the eggs. Forty percent had spots only on the yolks. About 20 percent had spots only in the chalazae and slightly over 20 percent had spots only in the albumen. The remainder of the eggs had spots in more than one position.

Fifty percent of the spots on the yolk were red, and only 5 percent were white (Table 7). Of the spots occurring in the albumen, 50

TABLE 7—Location and color of 1,561 spots found in New Hampshire eggs

Position	Color of spots*				
	1	2	3	4	5†
	(*percent of spots*)				
On yolk	6.5	2.3	8.5	32.1	50.6
In albumen	49.3	12.9	18.0	17.8	2.0
In chalazae	22.3	12.9	18.6	42.9	3.3

*1-White, 2-Light brown, 3-Medium brown, 4-Reddish brown, 5-Red.
†"Blood spots" as referred to in this paper.

percent were white and only 2 percent were red. The spots found in the chalazae were between those extremes, most of them being a shade of brown (Fig. 2).

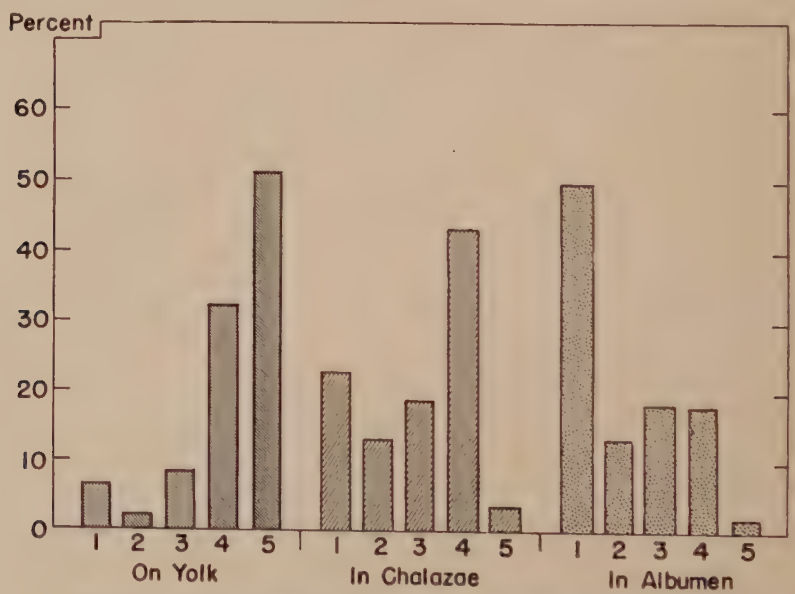

Fig. 2. Color of spots in relation to position within eggs. 1—White, 2—Light brown, 3—Medium brown, 4—Reddish brown, 5—Red.

Jensen, Sauter and Stadelman (1952) reported a total of 47.2 percent of blood and meat spots in newly laid eggs. Blood spots accounted for 16.8 percent of this total and meat spots 30.4 percent.

*TABLE 8—Location of meat spots**

Position	Meat spots
	(*percent*)
Yolk	14.3
Albumen	13.1
Chalazae	3.0

*Source—Jensen, Sauter and Stadelman, 1951.

These same investigators found that spots in eggs could be detected more readily in eggs several days old than in newly laid eggs. The maximum percentage of spots detected by candling in a field trial was after the eggs were 10 days old. Temperature at which the eggs were held affected the investigators' ability to detect blood spots. However, high temperatures cannot be recommended for holding eggs because of detrimental effects on albumen quality. They concluded that eggs should be at least 3 days old before being candled if optimum detection of blood spots is to result.

Jensen, Sauter and Stadelman (1951) found that small blood spots begin to disappear shortly after the eggs are laid. This disappearance is presumably caused by a chemical reaction which occurs at high temperatures. Thus, many small spots apparent in newly laid eggs probably will disappear before eggs reach the consumer through normal marketing channels.

INTERPRETATIONS

Recent investigations have dispelled the theory that most meat spots consist of glandular tissue which becomes incorporated into the egg during its formation. It is now thought by many investigators that about 95 percent of all blood and meat spots are formed by a hemorrhage during the growth of the yolk.

The incidence of spots varies greatly among breeds and strains of chickens. Leghorn eggs contain fewer spots than do eggs from the American breeds laying brown shelled eggs. The percentage of blood red spots are about the same for each breed, but there are more brown

and white spots in the brown-shelled eggs of Rhode Island Reds, White Rocks, Barred Rocks and New Hampshires.

The frequency of spots increases during the pullet laying year from September through the year to August. The incidence of spots decreases during the second and third laying years.

An unknown factor affects the incidence of spots. Birds turned out on range lay fewer eggs with spots than do confined birds.

Inheritance plays an important role in blood and meat spot incidence. Percentage of eggs with spots can be decreased by proper selection of dams and sires for the mating pen.

The largest percentage of spots is found on the yolk. About the same percentage is found in the chalazae as in the albumen. Most of the spots on the yolk are blood red, whereas most of the spots in the albumen are white or light brown. Spots in the chalazae are intermediate in color.

Blood spots can be more readily detected by candling eggs that are a few days old than in newly laid eggs. This is probably caused by a thinning of the albumen which allows the egg contents to revolve more rapidly when the egg is candled.

Blood spots tend to change to a lighter color when held at relatively high temperatures. Some spots apparently disintegrate and gradually disappear when eggs are held. High temperatures speed up this process.

Economically, blood and meat spots represent a considerable loss to the poultry industry. Not only is there a direct loss of the eggs candled out with spots, but there is a decreased demand for eggs every time blood spot eggs are encountered in the frying pan. If there were no such spots in eggs, those marketing eggs direct to consumers might save considerable time and reduce their costs by eliminating this candling operation.

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PERCENTAGE MORTALITY OF PULLETS IN THEIR FIRST LAYING YEAR COMPARED WITH SURVIVORS THE SECOND YEAR

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IT IS TRITE BUT TRUE to state that the mortality among laying flocks is one of the most important problems of poultry producers. Evidence of the extent of mortality can be obtained from a multitude of sources. A recent report, which is perhaps one of the most representative on flocks in general, concerns the "New York Random Sample Poultry Test." Its author, King (1951), indicates a mortality rate of Leghorn pullets during the first laying year of 33.6 percent and for "heavy" breeds 35.7 percent. Whitfield (1951) states that the mortality rate of Leghorns in Iowa Demonstration Farm Flocks was 17.3 percent, that of Rocks, 14.8 percent, New Hampshires 14.8 percent, and Hybrids 30.5 percent. On the other hand, the average mortality of over 12,000 birds of various breeds entered in the 1950-51 U. S. Official Egg Laying tests is given by the Council of American Official Poultry Tests as 14.5 percent.

There may be some basis for an assumption that birds entered in official laying tests represent the most highly selected population available and that viability may be improved by selection. More definite evidence that viability may be improved by breeding may be found in a recent review by Jull (1952).

To test for viability it is necessary to retain birds for more than one laying year. Such a practice suggests the question of the relationship of first year to second year viability. In other words, does ability to live through the four seasons of the first laying year indicate general viability or resistance to common diseases? If first-year viability is an index of future viability, poultry producers might improve viability in breeding flocks simply by keeping healthy birds a second or third year or until they become uneconomically productive.

ARTICLE 35-15

As for diseases for which specific medicinal cures or preventatives are unknown, search for naturally resistant stock is about all that offers promise.

A recent report from the Kentucky Station by Insko, Lowry and Caldwell (1951) indicates that the percentage mortality among selected hens was greater in the second year than in the original flock the first year. Unfortunately there was not enough information to permit an evaluation of the circumstances under which the Kentucky data were compiled or a statistical analysis. The flocks were not trapnested and presumably not identified individually, nor was there a distinction between birds lost from disease and other causes.

OBJECTIVE

It is the purpose of this report to present the mortality records for the past 5 years from Michigan Agricultural Experiment Station breeding flocks and to compare the percentage mortality of first-year pullets with that of their flock mates retained during their second laying year.

MANAGEMENT OF STOCK

The data compiled and analyzed in Table 1 are from pullets and hens individually identified, trapnested and managed more or less in a uniform manner, much as any breeder might. Pullets were leg banded each fall and kept confined continuously throughout the year in uniform-sized concrete-floored pens. Feed and management were as nearly uniform as possible. Records of the fate of every individual

TABLE 1—Mortality of first-year pullets compared with that of flock mates retained the second year

	Number birds pullet year	Percent mortality	Number birds second year	Percent mortality
1945-46	514	29	110	22
1946-47	523	25	92	14
1947-48	826	12	140	16
1948-49	700	8	192	13
1949-50	684	19	133	12
Total	3,247	.....	667	.....
Average 5 years	650	17**	135	14**

**Difference highly significant statistically.

bird were kept, so that losses from accidents, cannibalism, etc., could be distinguished from those caused by disease. Efforts were made to get autopsy reports from the Poultry Pathology Department[1] for each bird, but the birds were not always in condition for satisfactory autopsy. Birds found dead or those which were sick when culled were recorded as lost from disease whether they were autopsied or not. Some culling for production reasons was practiced from about May to September each year, but the culling probably was not so drastic as that commercially practiced. At the end of the first laying year, in September usually, hens retained were moved to new pens and from that time on until the next fall they were classified in the records as yearling hens.

HYGIENE

The only vaccination procedure followed was that against fowl pox during the 12th-16th week period while pullets were on range. No medication of any kind was given other than routine treatments of roosts with Black Leaf 40 as an insecticide. Pens were "dry cleaned" periodically from once to four times each month and fresh straw litter was provided after cleaning.

MORTALITY SUMMARY

The percentage mortality of first-year pullets and flock mates retained a second year is indicated in Table 1. It is evident from this table that there was a tendency for mortality to decline from the first to second year; a decline occurred in 3 out of 5 years. In the two instances where there was an increase in mortality during the second year it was slight and occurred in cases where first-year mortality was unusually low. The average difference in mortality does not appear to have been very great, but it is highly significant statistically.

There was a decline in first-year mortality from year to year for the first 4 years of this study, which might be attributed to the selection program, but the rate of decline should be discounted somewhat by the slightly higher-than-average mortality in the fifth year. The breeds involved consisted of approximately equal numbers of White Leghorns, Dark Cornish, and crossbreds which were various combinations of the Cornish and Leghorns.

[1]All autopsy work was done by the Poultry Pathology Laboratory under the general supervision of Dr. H. J. Stafseth. Dr. R. C. Belding has been directly responsible for autopsy work since 1949.

NO EPIDEMICS

No severe epidemics were prevalent at any time during the 5-year period. Up to date, Newcastle disease has not been diagnosed in the station flock. The percentage loss from the leukosis complex was low. According to data from the M. S. C. diagnostic laboratory, cited by Zindel (1950), the loss from the leukosis complex was 8 percent. This estimate made no distinction between age or sex of birds. It is customary in many reports involving the leukosis complex to use the age of 500 days as the test period for comparison. A reexamination of the records by the writer, on a 500-day basis, indicated that the mortality from the leukosis complex among pullets was only 6 percent of the total diagnosed. An incidence of 6 percent is lower than the "resistant" strain of the U. S. Regional Laboratory as cited by Winton (1951) and nearly the same as the resistant line of Hutt and Cole (1948) as cited by Jull (1952).

UTILITY OF RESULTS

The fact that the mortality rate among pullets retained in their second year is significantly lower than that of their flock mates in the previous laying year suggests a means of reducing death losses among farm flocks. There is a well known economic disadvantage in the practice of retaining pullets for a second laying year which must be considered in relation to the probable viability gain from the practice. Hens molt normally at the end of their first laying year and remain out of production from 2 to 3 months after their first laying year unless they are provided with a "spring time" light day of 13 or 14 hours. There have been various estimates of the normally expected difference between first- and second-year egg production. Brody, Henderson and Kempster (1923) found originally that the rate of decline of egg production with age among several breeds was about 13 percent. Later Hall and Marble (1931) showed the decline to be 14 percent among more than 1,800 Leghorns.

The probable cost of replacement of pullets is another factor which must be considered along with advantages and disadvantages of retention or culling.

If mortality is as high as indicated by the New York Random Sample Test (with resultant low production per pullet housed), it might be good management to retain healthy pullets that had demonstrated ability to live, for a second laying year. Breeding from hens tested in this manner is about all that offers much promise at the

present time in the reduction of mortality from many of the common poultry diseases.

SUMMARY AND ABSTRACT

The average rate of mortality of approximately 650 pullets per year for 5 years was 17 percent as compared with 14 percent for their retained flock mates during their second laying year. The difference is statistically significant. Breeds consisted of approximately equal numbers of White Leghorns, Dark Cornish and various cross-bred combinations of the two breeds. There was a marked decline in the mortality rate of all pullet progeny per year from 1945 to 1949 (29 to 8 percent), but the mortality rate of pullet progeny in the fifth year (1950) was 19 percent. The utility of the information in management practice is suggested.

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A SILVER-LACED CHICKEN WITH CORNISH ANCESTRY

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IT IS ADVANTAGEOUS very often to be able to distinguish the sex of chicks at hatching time. The broiler grower wants all male chicks, and the egg farmer frequently wants all female chicks. It is well known, of course, that the sex of any breed of chicks can be determined by people especially trained in the art, which was introduced in this country many years ago by the Japanese.

It is well known, also, that the sex of some breeds of chicks can be determined by differences in color. Unfortunately, some of the breeds which can be sexed easily by color lack some of the characteristics desired, such as high egg production, fast growth, or being of a good meat type. Cross-breeding is frequently resorted to in order to combine some of the desired characteristics, and some new "breeds" have been developed.

SILVER COLOR PERMITS AUTO-SEXING

Among the desirable colors for crossing purposes are varieties which carry the silver (white) color such as Silver-laced Wyandottes or Columbian Plymouth Rocks. Rhode Island Reds and New Hampshires have been crossed on the afore-mentioned breeds frequently, resulting in combinations which could be sexed at hatching but these represent little, if any, improvement in meat type. A need exists, therefore, for an auto-sexing variety which has good meat type along with enough growth and egg-producing ability so that these characteristics will not be deficient in the progeny.

EGG PRODUCTION AND MEAT TYPE

Experiments to develop good egg production in an extremely good meat-type breed (the Dark Cornish) have been reported by Hender-

ARTICLE 35-16

son.[1] Up to date the Cornish breed has lacked a color variety which would permit satisfactory sexing of chicks at hatching time.

A SILVER-LACED "MUTATION" WITH GOOD MEAT TYPE

The objectives of this report are to call attention to a silver "mutation" with considerable Cornish ancestry that will permit auto-sexing of chicks at hatching time and to describe the ancestry of the "mutant".

Seven silver-laced chicks, one of which is illustrated in Fig. 1, were obtained from the Michigan Station flock in 1951 from synthetic silver-

Fig. 1. A silver "mutation" with considerable Cornish ancestry.

pencilled males mated to red crossbred females. The "synthetic" silver-pencilled males were sired by a silver-pencilled "mutation" hatched in 1948. According to pedigree records from single-male-mated pens, the silver-pencilled "mutation" of 1948 was from a White Laced Red Cornish dam by a Dark Cornish male, but it was not reported at the time because of the possibility that a columbian-colored male in

[1]Henderson, E. W. A white laced red color pattern of chickens from a dark Cornish × White Leghorn cross. Mich. Agr. Expt. Sta. Quart. Bul. 30 (1): 29-37. 1947.

the pen adjacent to the dam may have been the sire of the "mutant" silver-pencilled male.

There can be little doubt, however, that the silver-laced chicks in 1951 came from the ancestry indicated since there have been no silver-laced chicks of any breed on the station plant for the past 13 years.

This incident is reported for whatever light it may shed on the inheritance of color patterns and the independence of color genes from pattern genes as suggested by Henderson[2] (1947).

The pedigree by breeds of the silver-laced progeny is indicated in Fig. 2.

There are several color "mutations" in the pedigree of the silver-laced progeny that have not been reconciled with existing genetic theories. Male No. 4840 can be described briefly as a blue-laced white. He was sired by a black and white barred crossbred male of White Leghorn × Dark Cornish ancestry. His color pattern was rather indistinct and somewhat like the general appearance of a cuckoo-colored male.

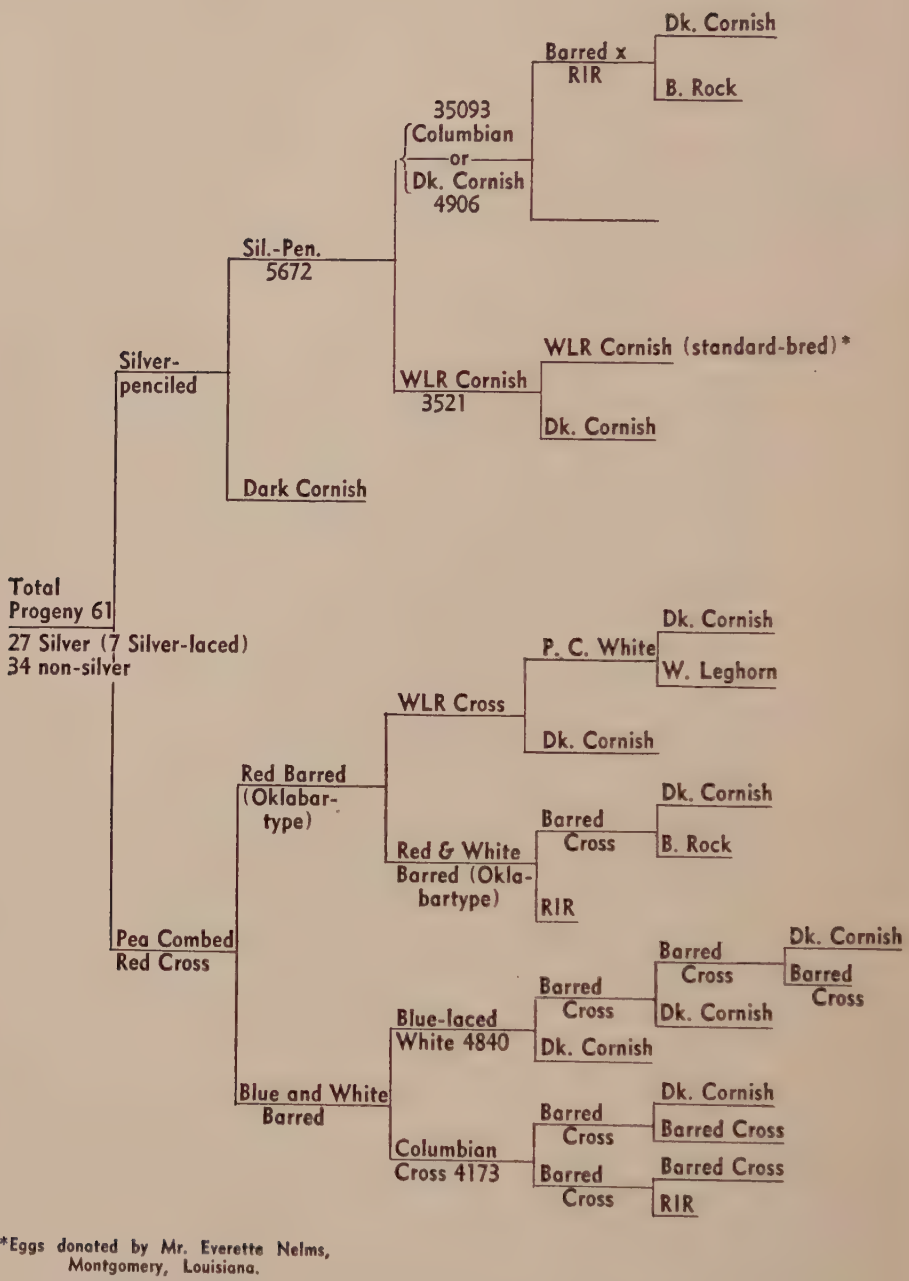
There is not much if any evidence in the literature that the columbian color pattern is carried by barred varieties such as Barred Rocks, although it is thought that White Rocks carry this pattern. Hen No. 4173 was predominately columbian[3] in color, which presumably she got from sire No. 6855 which was of Cornish × White Leghorn ancestry. Male No. 35093 was distinctly columbian or light silver from Dark Cornish × Barred Rock × Rhode Island Red ancestry. If he was not the sire of 5672 then the silver of 5672 presumably came from No. 3521 (a White-laced Red Cornish), a phenomenon which could not be reconciled with current theories. It seems possible, however, that No. 3521 may carry silver, for Henderson (1947) has repeatedly obtained silver-barred (black and white barred) progeny from synthetic White-laced Reds. A black-and-white barred male was hatched from No. 3521 in 1951. It was sired presumably by a White-laced Red male.

The silver-laced "mutants" have been bred to Rhode Island Reds and some crossbreds in an effort to establish their genetic composition.

The term "mutant" may not be warranted as descriptive of the silver-laced phenotype described herein. A silver-laced phenotype (Silver Sebright Bantam) has been officially recognized by the American Poultry Association since 1874. The genetic origin of the official phenotype is unknown; therefore, no comparison can be made with

[2]See footnote [1].

[3]There were no birds of the columbian phenotype at the Station plant prior to this "mutation".



*Eggs donated by Mr. Everette Nelms, Montgomery, Louisiana.

Fig. 2. Pedigree of the silver-laced progeny.

the genotype apparent in the pedigree shown in Fig. 2. The phenotype illustrated in Fig. 1 is assumed to be merely the product of a chance recombination of recessive and dominant genes or simply a genotype. A part of its gene complex is probably Ss (silver) la la (lacing). Additional postulations are possible but unwarranted from the data.

COLORS FOR PRODUCING SEX IDENTIFIABLE CHICKS

Although it has been demonstrated in this experiment that sex of chicks could be identified at hatching by crossing the Rhode Island Reds, New Hampshires or Dark Cornish on silver-laced females, other stations have reported that columbian or barred females may be used as well. Male chicks of such crosses will carry considerable light or

Fig. 3. How the silver-laced "mutant" may be mated for sex identification of chicks.

white stripping in the down and will be very light or nearly white at broiler age. Unfortunately, the females (especially from the Barred Rock cross) will be almost entirely black with a small amount of red on the head and neck only. A silver-laced variety in which both males and females will carry considerable silver or white along with good meat type and egg production is in process of development. Many of the females from this cross are not black but red, which is probably less objectionable from a market standpoint.

SUMMARY AND ABSTRACT

Silver-laced auto-sexing "mutant" (black laced white) progeny were obtained from a silver-pencilled cross-bred male mated to a red cross-bred female. The color pattern illustrated is quite similar to that of the Silver Laced Wyandotte. The pedigree of the mutants for six generations includes a predominance of Dark Cornish individuals, some Barred Rocks, White Leghorns and Rhode Island Reds, but no Wyandottes.

ARE FARM ACCOUNT COOPERATORS BETTER THAN AVERAGE FARMERS?

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IN FARM MANAGEMENT research and extension work in Michigan, reference is made frequently to the farm account records of farmers participating in the Michigan Farm Account Project. Each year farmers throughout the state cooperate with Michigan State College in this project, which was started in 1929.

Cooperating farmers keep records of their annual business activities. These accounts are summarized at the College and are analyzed for each operator. Information regarding the efficiency and profitability of each farm can be drawn from this analysis and can be used in developing future farm plans. The individual reports are summarized by type-of-farming areas to give a broader picture of farming in a region where the type and conditions of farming are similar. These area reports provide useful information and guideposts for all phases of farm management work.

Questions regarding the size and efficiency of operation often arise when these farm records are discussed. To provide an answer for such queries, a brief comparison is made here of the farming operations of farm account cooperators with other farmers in three type-of-farming areas in Michigan. Type-of-farming areas selected for comparison were areas 1, 5, and 8. These are important agricultural areas in south-central Michigan in which crop and livestock (especially dairy) farming is predominant.

In type-of-farming area 1 are three counties: Hillsdale, Lenawee, and Monroe. Counties in type-of-farming area 5 are Clinton, Eaton, Ingham, Ionia, Jackson, Shiawassee, Genesee, Livingston and Washtenaw. In type-of-farming area 8 are Bay, Midland, Gratiot, Saginaw, Tuscola and Huron counties. While the area boundaries do not follow county lines, these counties constitute all but a small part of each area. Data from the Bureau of the Census and from the Bureau of Agricul-

ARTICLE 35-17

tural Economics, United States Department of Agriculture are combined by these county groups (type-of-farming areas) for comparison with the records of farm account cooperators.

The first question asked is usually, "*Are the farms of account cooperators larger than the average for the area? And, if they are larger, how much larger than average are they?*"

Average acreages of farms in 1945 as reported by the Bureau of the Census and for farm account cooperators for the selected areas of Michigan are presented in Table 1. The year of 1945 was selected

TABLE 1—Comparison of average size of farms for the region and for farm account cooperators, selected areas in Michigan, 1945

Type-of-farming area	Census*	Account cooperators' farms†	Difference
	(acres)	(acres)	(percent)
1	131	179	38
5	148	206	39
8	129	162	26
Average, weighted	138	186	35

*Data from the 1945 Census of Agriculture for Michigan, Bureau of the Census, United States Department of Commerce. Only farms of 50 acres and over were included.

†Range in size was from 45 to 738 acres.

since it was the midpoint of the 10-year 1941-50 period under study. Only farms of 50 acres and over were included in the average acreages computed from the Census reports. This was done to make the comparison more meaningful, since the range in size of the cooperators' farms was from 45 to 738 acres. In addition, it was felt that in most instances farms of less than 50 acres in those areas were not commercial farms.

As the data in Table 1 indicate, the farms of account cooperators in the combined areas were 35 percent larger than the average for the areas as reported in the 1945 Census of Agriculture.

Next comes the question, "*Are the account cooperators better farmers than the average in the area? And, if they are better, how much better than average are they?*" The difficulty in answering these questions comes in finding some means of measuring farming ability. Since comparable records are not available for all farms in the state,

many of the most significant measures of efficiency such as dairy sales per cow, egg sales per hen, and income per acre cannot be used.

Crop yields per acre, however, provide one measure of farming efficiency which one can use in answering the questions. Yield figures are especially useful because they are available on a comparable basis, both for farm account cooperators and for all farmers in the state.

The average yields for all farmers as reported by the Crop Reporting Service of the Bureau of Agricultural Economics of the U. S. D. A. in cooperation with the Michigan Department of Agriculture and for farm account cooperators for selected areas of Michigan have been summarized for the 10-year period, 1941 through 1950. The results are presented in Table 2.

TABLE 2—Comparison of average crop yields for the region and for farm account cooperators, selected areas in Michigan, 1941 through 1950

Item	Average annual yields per acre, 1941 through 1950								
	Type-of-farming area 1			Type-of-farming area 5			Type-of-farming area 8		
	CRS	FAC	Difference	CRS	FAC	Difference	CRS	FAC	Difference
			(percent)			(percent)			(percent)
Corn.....bu.	43	46	7	37	41	11	36	46	28
Oats.....bu.	40	40	0	40	41	2	41	48	17
Wheat.....bu.	26	27	4	25	27	8	26	29	12
Hay.....ton	1.6	1.8	12	1.5	1.8	20	1.4	1.9	36
Difference, average*.....	.....	.....	7	.....	.....	11	.....	.....	25

CRS —Crop yields reported by the Crop Reporting Service of the Bureau of Agricultural Economics of the United States Department of Agriculture in cooperation with the Michigan Department of Agriculture.

FAC —Crop yields of Michigan Farm Account cooperators. Average number of cooperators for the 10-year period: area 1—97; area 5—163; and area 8—95.

*Weighted by total acreage of each crop as reported by account cooperators.

Yields of only four major crops—corn, oats, wheat and hay—are shown. These were selected since they are important in Michigan agriculture and are grown extensively in the three areas selected.

As shown in Table 2, for each crop and in each area the yields of account cooperators were equal to or greater than the yields reported by the Crop Reporting Service as an average for that area and crop.

To get an idea of over-all cropping efficiency, the percentage differences in yields of the four crops were combined for the areas. In order to reflect the relative importance of each crop in the total picture, the

differences in yield for each crop have been weighted in terms of the acreage grown.

The combined crop yield of account cooperators in type-of-farming area 1 was 7 percent greater than the average combined crop yield in that area as reported by the Crop Reporting Service. In type-of-farming area 5, the cooperators' combined crop yield was 11 percent above the area average. And in type-of-farming area 8, where the greatest difference was shown, the combined yields of the four crops for the account cooperators was 25 percent above the average for the area. Type-of-farming area 8, although predominantly an area of good land, does have considerable areas of lighter soils. It is quite possible that for this particular area a larger proportion of the farm account cooperators than of the crop reporters, came from the better soil areas and thus reflect greater yield differences than actually exist.

Thus, one finds that the farms of farm account cooperators in those three areas were about one-third larger than the average in the areas. If he uses crop yields per acre as a measure of farming efficiency, he will find the account cooperators to be better farmers than the average in the areas. And how much better? In those three areas, account cooperators' combined yields for the four crops were from 7 to 25 percent greater than the average as reported by the Crop Reporting Service.

JOURNAL ARTICLE ABSTRACTS

Relationship of Weight and Body Measurements of Adult Smelt, Osmerus Mordax (Mitchill)

Baten, William Dowell, and Tack, Peter I.

The Progressive Fish Culturist 14(2):50-55. 1952 [*Journal Article 724 from the Michigan Agricultural Experiment Station*]

This article gives the linear relationships of various body measurements of male and female smelt. Predicting equations are given for estimating body weight from standard length, width and depth. The various equations for males differ considerably from those pertaining to females. Predicting logarithmic equations for weights are also given for both sexes. There is very little difference between the linear equations and the logarithmetic equations. The equations for predicting weight from the cube of the standard length are about the same for males and females. The predicting equations for estimating weight from the product of length x width x depth for the sexes are about the same. In every case standard errors of estimate were calculated for determining the accuracy of the estimated values. Correlation coefficients between various measurements are given also for determining those relationships.

The Normal Pattern of Solar Radiation at East Lansing

Crabb, G. A., Jr.

Papers Mich. Acad. Sci. Arts and Letters 36:173-176. 1950 [*Journal Article 1144 from the Michigan Agricultural Experiment Station*]

The paper discusses the importance of radiant energy from the sun to agriculture in general, hydrology, engineering design, plant physiology, horticulture, botany, and similar fields. It defines specific terms used in the measurement of this energy and discusses various factors affecting the amount of solar energy at the surface of the earth. General comparison is made of the amount of solar energy received at East Lansing with that received normally at other stations. The pattern of normal receipt is discussed, and weak points in the method customarily in use for developing this normal pattern pointed out. A new method for determining the normal annual pattern of solar radiation is described, and its advantages and method of computation are given. The new pattern is illustrated and compared with the pattern developed under previous methods. Some effects of variation in solar radiation upon different crops are noted, and the use of the new pattern in evaluating these effects is shown. The paper is illustrated and referenced.

Survival of Salmonella pullorum on the Skin of Human Beings and in Eggs during Storage and Various Methods of Cooking

STAFSETH, H. J.; COOPER, MARGARET M., AND WALLBANK, A. M.

Jour. Milk and Food Tech. 15(2):70-73, 80. 1952 [Journal Article 1188 from the Michigan Agricultural Experiment Station]

Salmonella pullorum causes a dysentery-like disease in human beings. It seemed desirable to know the organism's survival time under the conditions indicated in the title. No recovery could be made from the skin of the back of the hand of a young woman 10 minutes after application (summer). It was recoverable after 45 but not after 60 minutes in the winter. It was recovered from eggs stored 8 months at 25° C. and 5 months at 4° C. The usual methods of cooking did not destroy all pullorum bacilli in eggs. Scrambling and 4-minute boiling were most effective.

Effects of the Removal of the Fish Population on the Fish-Food Organisms of a Lake

BALL, ROBERT C., AND HAYNE, DON W.

Ecology 33(1):41-48. 1952 [Journal Article 1210 from the Michigan Agricultural Experiment Station]

Qualitative and quantitative sampling of those benthic invertebrate organisms important as fish food in a 10-acre natural lake was carried out for a period of two complete years. The fish were then removed and the sampling of the fish-food organisms continued for one year. Following the removal of the trophic layer constituting the primary and secondary carnivores, the standing crop of benthic organisms increased to an equilibrium level approximately twice the mean annual crop prior to the removal of the fish.

Anatomical Study of Root Inhibition in Stems of Vaccinium Corymbosum L. in Relation to Associated Fungi

MAHLSTEDE, JOHN P., AND WATSON, DONALD P.

The Botanical Gazette 113(3):279-285. 1952 [Journal Article 1219 from the Michigan Agricultural Experiment Station]

Hardwood cuttings of *Vaccinium Corymbosum* L. were rooted under aseptic conditions to study the influence of nine associated fungi on rooting. Description is given of the methods used and the techniques of inoculation. Stem anatomy is discussed in relation to the part used for propagation. Roots were found to originate in the cambium and phloem and project through the callus or through the outer stele, cortex and epidermis. Descriptions are given of the mechanical inhibition of root projection by the lignified pericyclic fibers and closely packed epidermal cells cemented together by a thick cuticle on the outside of the stem. It is suggested that if some means of dissolving the cuticle epidermal layer—and even the pericyclic fibers—could be provided, rooting percentages might be improved. No relationship was established between the presence of the fungi and the amount of root development.

Foliar Application of Phosphatic Nutrients to Vegetable Crops

SILBERSTEIN, O., AND WITTWER, S. H.

Proc. Am. Soc. Hort. Sci. 58:179-190. 1951 [Journal Article 1220 from the Michigan Agricultural Experiment Station]

Several organic and inorganic compounds were tested as possible sources of available phosphorus when applied to the leaves of plants. Tomato, bean, and corn plants grown at low phosphorus levels gave definite growth responses to foliar applied phosphorus as indicated by height and flesh weight measurements. Early yields of field tomatoes were increased significantly by four weekly sprays of a 25 millimolar solution of o-phosphoric acid. Foliar applied phosphorus was utilized much more efficiently than phosphorus applied broadcast to the soil. A concentration of 25-50 millimoles of phosphorus per liter was found most desirable for the greatest number of compounds when a wetting agent was added. Generally, o-phosphoric acid was the most effective of all chemicals as a source for plant utilization of foliar-applied phosphorus.

Tracer studies have established that foliar-applied radioactive o-phosphoric acid is rapidly absorbed by the leaves of the tomato, corn, bean and squash plants and translocated to the root tips and other centers of high metabolic activity. Apparently, within 48 hours of treating, 5 to 6 percent of the total phosphorus in developing tomato fruit may be derived from a single foliar application of a 25-millimolar solution of o-phosphoric acid.

Retardation in Cell Development in Leaf and Flower Buds of Phaseolus Vulgaris L. from Foliar Applications of Maleic Hydrazide

WATSON, DONALD P.

Bulletin Torrey Botanical Club 79(3):235-241. 1952 [Journal Article 1226 from the Michigan Agricultural Experiment Station]

One hundred bean plants were grown in nutrient solution under controlled conditions of light and temperature. Plants were selected for uniformity, and 25 plants with 3-4 mm. buds were sprayed with 500 p.p.m. of the active ingredients of the diethanolamine formulation of maleic hydrazide. Inhibition of growth and reduction of size of all above-ground parts were caused by this treatment. Leaves failed to expand laterally. There was inhibition of cell differentiation but no apparent abnormal cell multiplication or development. Abscission of parts, followed by rapid lateral growth was observed. Abscission zones in petioles of treated plants developed rapidly. Reproductive parts developed in the bud before abscission took place, but they were delayed in their growth as were leaves and stems.

Experimental Storage of Cut Peony Flowers

OHLANDER, MARGARET C., AND WATSON, DONALD P.

Proc. Am. Soc. Hort. Sci. 58:371-376. 1951 [Journal Article 1237 from the Michigan Agricultural Experiment Station]

Variety Felix Crousse peony is superior to either Reine Hortense or Walter Faxon for long-term storage at 35° F. Storing peonies in waxed boxes sealed in

cellophane appears to increase their storage life. In general, keeping qualities after removal to room temperature, varies inversely with the length of the storage period. After 60 days in storage and 4 days at room temperature 61 percent of Felix Crousse, none of Reine Hortense, and 36 percent of Walter Faxon were in a salable condition. Fungi isolated from the peonies in storage were identified as *Alternaria humicola* and *Fusarium sp.* Paradichlorobenzene (P.D.B.) completely controlled fungal growth on peonies in cellophane-sealed wax boxes stored at 35° F. for over 73 days. P.D.B. used at 2 or 4 grams per 420 cubic inches prevented the growth of *Alternaria humicola* but did not prove lethal. P.D.B. caused severe injury to the foliage but not to the flowers. This injury was not sufficient to be objectionable until after 59 days in storage.

Antithyrotoxic Effects of Antibiotics in Rats

MEITES, JOSEPH, AND OGLE, R. C.

Proc. Soc. Exp'l Biology and Med. 77:758-761. 1951 [Journal Article 1250 from the Michigan Agricultural Experiment Station]

1) Three crystalline antibiotics were fed to 100 male and female rats to determine whether they could counteract the retardation of growth induced by feeding thyrotoxic amounts of Protamone. On a ration adequate in vitamin B_{12}, penicillin or neomycin but not streptomycin were completely effective in overcoming the growth-inhibition, while on a ration deficient in vitamin B_{12}, all three antibiotics were only partially effective. As for animals on the deficient ration, the antibiotics reduced the survival rate of the hyperthyroid rats.

2) At least part, if not all, of the effectiveness of the antibiotics in counteracting growth retardation could be attributed to the increase in food consumption and to an increased efficiency in converting food into body weight gains. The antibiotics did not alter the 74 percent increase in basal oxygen consumption induced by the Protamone, nor did they change the action of the latter on adrenal and spleen weight. Thymus atrophy was partially or completely prevented by the antibiotics.

Benzylamine as a Reagent for the Characterization of Isothiocyanates

WELLER, LOWELL E.; BALL, CHARLES D., AND SELL, HAROLD M.

Jour. Am. Chem Soc. 74:1104. 1952 [Journal Article 1276 from the Michigan Agricultural Experiment Station]

The characterization of a number of isothiocyanates by the use of benzylamine as a reagent is reported.

The Response of Inbred Lines of Chickens to Lymphoid Tumor Transplants

EL DARDIRY, AHMED H.; WATERS, NELSON F., AND COTTRAL, GEORGE E.

Poultry Sci. 31(3):523-534. 1952 [Journal Article 1277 from the Michigan Agricultural Experiment Station]

The primary objectives of this study were 1) to determine the reaction of chickens within certain inbred lines to lymphoid tumor transplants, and 2) to dis-

cover whether the chickens of certain inbred lines that had been selected for resistance or susceptibility would show a similar degree of resistance or susceptibility to transplants of lymphoid tumor cells. Altogether, 2,027 Single-comb White Leghorn chickens of both sexes and involving eight different inbred lines were used. All chickens were inoculated in the pectoral muscle with lymphoid tumor cells at 21 days of age. The experiment was terminated 28 days after inoculation. Shortly after inoculation all chickens except three showed tumor growth. Marked differences in mortality occurred in the different lines after inoculation with lymphoid tumor cells. However, death occurred only after tumor cells invaded the viscera. If death did not occur prior to 28 days following inoculation, in nearly all cases there was a complete regression of the tumor. Thus, the presence or absence of visceral tumors following inoculation of lymphoid tumor cells in the pectoral muscle provided the best measurement of resistance or susceptibility. When the composite data were analyzed on a family basis, there was no indication that resistance or susceptibility to tumor transplants measured resistance or susceptibility to naturally occurring lymphomatosis.

Inactivation of Prolactin by Various Body Tissues in Vitro

SCOURIS, J. T., AND MEITES, JOSEPH

Am. Jour. Physiology 169(2):301-304. 1952 [*Journal Article 1281 from the Michigan Agricultural Experiment Station*]

Prolactin was incubated *in vitro* for 1 hour at 38° C. with the following tissues: liver, kidney, brain and muscle of rats; mammary gland from lactating and nonlactating guinea pigs and rabbits; pigeon crop glands; corpora lutea and the remaining ovarian tissue from pseudopregnant rabbits. After incubation the prolactin was assayed in pigeons and directly compared with an equivalent amount of prolactin which had been incubated in a tissue-free solution.

On a fresh tissue basis, mammary gland, pigeon crop gland and the two ovarian tissues showed the greatest capacity to inactive prolactin. Lactating mammary slices appeared to be more effective in that respect than nonlactating mammary slices. Liver and kidney inactivated only about half as much prolactin as the preceding tissues, while muscle and brain had no effect on the prolactin. Liver and kidney homogenates were more effective in removing prolactin than slices of these tissues. When any of the tissues were boiled for 10 minutes prior to incubation with prolactin, they lost their ability to inactivate the hormone.

Alleviation of Cobalt Toxicity in Calves by Methionine Administration

DUNN, K. M.; ELY, R. E., AND HUFFMAN, C. F.

An. Sci. 11(2):326-331. 1952 [*Journal Article 1292 from the Michigan Agricultural Experiment Station*]

Ten calves fed a normal ration and injected (intravenously) with 0.37 to 0.82 mg. of elemental cobalt per pound of body weight developed the following toxic symptoms: lacrimation, salivation, dyspnea, incoordination, defecation and urination. In addition, in seven animals which received injection (intravenously) of cobalt ranging from 0.49 to 0.84 mg. per pound of body weight and also received previous injection (intravenously) of either 500 or 1000 mg. of methion-

ine per animal, the severity of the toxic symptoms was prevented or markedly reduced. Cobalt and methionine apparently form a coordination complex in the blood which is less toxic than cobalt *per se*, as evidenced by the lack of stimulation of the thoracico-lumbar sympathetic system as indicated by failure of occurrence of cobalt toxicity symptoms. The M. L. D. of cobalt injection (intravenously) is more than 4 mg. per pound of body weight for the dairy calf.

Pullorum Disease Studies in Turkeys. V. On the Chemical Nature of the Factor Responsible for Zone Reactions in the Tube Agglutination Test for Pullorum Disease in Turkeys

HEWES, WALTER E., JR., AND STAFSETH, H. J.

Poultry Sci. 31(4):632-638. 1952 [*Journal Article 1296 from the Michigan Agricultural Experiment Station*]

An attempt was made to determine the chemical nature of the factor responsible for zone reactions in tube agglutination tests for pullorum disease in turkeys. One-tenth percent phenol added to antisera tended to remove zone of inhibition and to reduce the end titers. Bovine albumin (20 percent) used as diluent of antigen removed the zone reaction. Absorption of antiserum also removed the agent which produced zone reactions. Chemical fractionation of antisera showed that sera giving no zone reaction had a higher globulin content than did the sera exhibiting strong zone reactions. Zones of inhibition in tube agglutination tests for pullorum disease in turkeys seemed to be caused by the presence of incomplete agglutinins. The incomplete agglutinins were species specific with regard to serological activity and had a greater affinity for antigens than did normal agglutinins. Strain 11 produced zone reactions, strains 4 and 10 did not produce zone reactions.

Effect of 2, 4-Dichlorophenoxyacetic Acid on Proteolytic Activity of Red Kidney Bean Plants

REBSTOCK, THEODORE L.; HAMNER, CHARLES L.; BALL, CHARLES D., AND SELL, HAROLD M.

Plant Physiology 27(3):639-643. 1952 [*Journal Article 1304 from the Michigan Agricultural Experiment Station*]

The proteolytic activity of the leaf, stem and root tissues of red kidney bean plants treated with 2, 4-dichlorophenoxyacetic acid and nontreated plants was determined using hemoglobin, glycylglycine, L-crystinyldiglycine, L-cystinyldiglycyldiglycine and chloroacetyl-L-tyrosine substrates.

With hemoglobin, glycylglycine and L-cystinyldiglycine substrates, the proteolytic activity of the non-treated leaves was almost double that of the treated leaves. The activity of the treated stems was approximately twice the activity of the non-treated stems, whereas the proteolytic activity of the treated roots was slightly less than the control roots.

Enzyme preparations of leaf, stem and root tissue did not hydrolyze chloroacetyl-L-tyrosine and L-cystinyldiglycyldiglycine.

When the nitrogen components of the treated and non-treated stem tissue were partially fractionated, the major portion of the increased nitrogen content of the treated stems was found in the protein fraction.

Trinitrobenzene Complexes of Various Indole Compounds

WELLER, LOWELL, E.; REBSTOCK, THEODORE L., AND SELL, HAROLD M.

Jour. Am. Chem. Soc. 74:2690. 1952 [Journal Article 1307 from the Michigan Agricultural Experiment Station]

The characterization of various indole compounds by means of trinitrobenzene complexes is described.

An Improved Synthesis for γ-methyl δ, γ, β butenolide

HOUFF, WILLIAM H., AND SELL, HAROLD M.

Jour. Am. Chem. Soc. 74:3183. 1952 [Journal Article 1308 from the Michigan Agricultural Experiment Station]

An improved synthesis is described for γ-methyl δ, γ, β butenolide.

Acceptability of Monosodium Glutamate in Frankfurters and Pork Sausage

PAUL, PAULINE C., AND LANGWORTHY, KATHERINE

Jour. Home Econ. 44(4):284-285. 1952 [Journal Article 1309 from the Michigan Agricultural Experiment Station]

Preference tests of frankfurters and pork sausage with and without added monosodium glutamate (MSG) indicated that the college students who tasted the samples could not distinguish between the two lots of frankfurters but had a definite preference for pork sausage containing MSG. It was suggested that the frankfurters were so highly seasoned as to obscure the added MSG for the inexperienced taster.

Canine Distemper: I. Bacteriological Studies

HSIUNG, GUEH-DJEN, AND STAFSETH, H. J.

The Cornell Vet. 42(2):223-231. 1952 [Journal Article 1310 from the Michigan Agricultural Experiment Station]

1. *Micrococcus pyogenes* var. *albus* was found to be the dominant organism present in the conjunctival and nasal discharge of all the dogs. Except for the presence of *Brucella bronchiseptica* in dogs infected with distemper, there was little difference between the bacterial floras of distemper-free dogs and those of distemper-infected dogs.

2. In addition to the above-mentioned organisms, other common bacteria encountered in the eyes and nose were *Micrococcus epidermidis*, *M. cascolyticus*, M. *aurantiacus*, hemolytic steptococci (groups C and D), and nonhemolytic streptococci. These organisms may be considered to be important secondary invaders accompanying canine distemper.

3. The clinical data showed that canine distemper is seasonal in its prevalence, the period of high incidence being November to April, with the highest peak occurring in January. Some, but not very significant, variation in the floras was observed in the various seasons.

4. Agglutination reaction was employed in the serological study. This work revealed no antigenic relationship between *Neisseria catarrhalis* of human and canine origin. The same was true in the case of human and canine strains of *M. pyogenes* var. *albus*.

Canine Distemper: II. The Value of Certain Therapeutic Agents Against the Bacterial Infections in Dogs Affected with Distemper

HSIUNG, GUEH-DJEN, AND STAFSETH, H. J.

The Cornell Vet. 42(2):232-237. 1952 [*Journal Article 1311 from the Michigan Agricultural Experiment Station*]

Eight drugs were used as local therapeutic agents in the eyes and nose of dogs affected with distemper.

1. Anticanine distemper serum was useless as far as local application is concerned.
2. The local use of two of the sulfonamides (5 percent sulfathiazole ointment and 30 percent sodium sulfacetamide solution) was not very effective in this study.
3. Baciguent ointment (500 units of bacitracin per gm.) was ineffective. Bacitracin (500 units per gm.) was effective when the infection was due to a single gram-positive organism, but of no avail on gram-negative bacteria.
4. Streptomycin solution (100,000 S units per ml.) was not effective against any of the secondary invaders in canine distemper.
5. Potassium penicillin ointment (28,000 units per gm.) was not so effective as calcium penicillin ointment.
6. Calcium penicillin ointment (14,300 units per gm.) gave the best results in the treatment of secondary infections of the eyes and nose in dogs accompanying distemper. Repeated applications are necessary for lasting beneficial results.

The Relationship of Protein to Pantothenic Acid and Vitamin B_{12} in the Growing Pig

LUECKE, R. W.; HOEFER, J. A., AND THORP, F., JR.

Jour. An. Sci. 11(2):238-243. 1950 [*Journal Article 1314 from the Michigan Agricultural Experiment Station*]

Symptoms of pantothenic acid deficiency were produced in pigs fed a low-protein (14 percent) ration containing corn, soybean oil meal, fish solubles and minerals. The addition of calcium pantothenate at a level of 4 mg. per pound of feed resulted in a very marked growth response.

The addition of calcium pantothenate to a higher protein (17.8 percent) ration, made up of the same feed constituents and containing the same level of pantothenic acid, resulted in only a slight increase in growth. However, this increase was not statistically significant.

The addition of vitamin B_{12} to both basal rations did not result in any significant growth response.

The data seem to indicate that higher levels of protein exert a sparing effect on the pantothenic acid requirement of the pig.

Effects of Vitamin B_{12} and Penicillin on Thiouracil Action in Chicks

LIBBY, DAVID, AND MEITES, JOSEPH

Proc. Soc. Exp'l. Biol. and Med. 79:370-372. 1952 [Journal Article 1315 from the Michigan Agricultural Experiment Station]

1. White Leghorn male and Rhode Island Red chicks of both sexes were fed vitamin B_{12}-deficient ration which was supplemented with 0.1 percent thiouracil and/or 0.5 to 4.0 μg percent vitamin B_{12} or 2 mg. procaine penicillin G per pound of food. After a preliminary depletion period of one and two weeks, respectively, on the vitamin B_{12}-deficient diet, the chicks were fed the above supplements for an additional 4- or 3-week period.
2. Thiousacil markedly reduced bodyweight gains and food intake in both breeds of chicks, and increased the grams of food required for each gram of gain in body weight. Vitamin B_{12} and penicillin partially or completely counteracted this growth depression and increased appetite. The larger doses of vitamin B_{12} were more effective in those respects than the smaller doses.
3. The large increase in thyroid weight and severe inhibition of comb growth induced by thiouracil were not influenced by the vitamin or antibiotic.
4. In general, these results corroborate previous data on the effects of vitamin B_{12} and antibiotics on rats fed thiouracil or following parathyroidectomy.

Increasing Labor Efficiency in Pre-packaging Meat

KRAMER, ROBERT C.

Jour. Farm Econ. 34(2):258-262. 1952 [Journal Article 1322 from the Michigan Agricultural Experiment Station]

A time study in a self-service supermarket which merchandised prepackaged fresh meat showed that labor efficiency in the meat department could be increased 25 to 30 percent by:

1. Designing the physical layout of the meat department on an efficient assembly-line basis.
2. Using the results of time-and-motion studies in the training of old and new employees.
3. Management impressing upon the employees the importance of doing a day's work for a day's wages.

Experimental Vibrio Fetus Infection in Goats

WEBSTER, H. D., AND THORP, FRANK, JR.

MSC Vet. 12(3):152-156. 1952 [Journal Article 1350 from the Michigan Agricultural Experiment Station]

Intravenous, cervical (intraperitoneal) and intrauterine routes of inoculation of *Vibrio fetus* in pregnant goats were compared. Intravenous inoculation of suspensions of *V. fetus* caused interference with the normal reproductive processes in four and the death of a fifth animal out of eight inoculated. Apparently little or no reaction was elicited by inoculation of the organism into the cervix. *V fetus*

was not isolated from uterine material in the intravenous or cervical groups. Intrauterine inoculations of *V. fetus* produced abortion, and the organism was recovered from uterine material of all four animals. Apparently the intrauterine method offers a means of studying the pathogenesis of this disease.

A Note on Vitamin A Therapy of Hyperkeratosis

WEBSTER, H. D.; DUNCAN, C. W.; HUFFMAN, C. F., AND THORP, FRANK, JR.

MSC Vet. 12(3):150-151. 1952 [*Journal Article 1351 from the Michigan Agricultural Experiment Station*]

A general slight improvement in appetite, skin condition and milk production was noted in a herd of grade cattle, displaying typical symptoms of hyperkeratosis (X-disease) after vitamin A therapy was instituted. The animals received approximately 120,000 to 360,000 I.U. of a synthetic vitamin A concentrate per week.

Listeriosis in Goats of Michigan

GRAY, M. L.; MILLERIC, THOMAS I., AND JOHNSTON, R. L.

MSC Vet. 12(3):157-159. 1952 [*Journal Article 1352 from the Michigan Agricultural Experiment Station*]

Three goats in a herd of five died over a 5-week period after showing nervous symptoms suggestive of listeriosis. Death occurred about 2 days after the onset of symptoms. One brain was cultured, and *Listeria monocytogenes* was isolated. Histologically, the brain revealed perivascular cuffing and focal areas of necrosis. This was the first known outbreak of listeriosis in goats in Michigan.

Agricultural Policy: Whose Valuations?

HATHAWAY, DALE E., AND WITT, LAWRENCE W.

Jour. Farm Econ. 34(3):299-309. 1952 [*Journal Article 1379 from the Michigan Agricultural Experiment Station*]

This article reports part of a study of farmers' attitudes toward government price support programs. A majority of the Michigan farmers interviewed desired a continuation of price supports at high levels, but were opposed to acreage and marketing controls. Their attitudes were not related to age, education, size of farm, indebtedness, or organizational affiliation. This information presents a challenge to extension educational programs, since farmers desire two goals which are inconsistent under conditions of less than strong inflation.

Michigan farmers were not strongly opposed to the use of direct government payments to support the price of perishable agricultural products. Their choice of support method appeared to be determined by the individual farmer's weighing of specific advantages and disadvantages of the support methods. For example, some farmers preferred direct payments because they believed the middleman would not benefit from the program, while others preferred the present support methods because they believed the administration would be simpler.

The implications of these attitudes towards means of support on the political position of farm groups and organizational leadership are also discussed.

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